



# Rescue kit for floods

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Need

Life  
Rescue  
Survival





# Rescue Vehicle for Floods

Need and Motivation

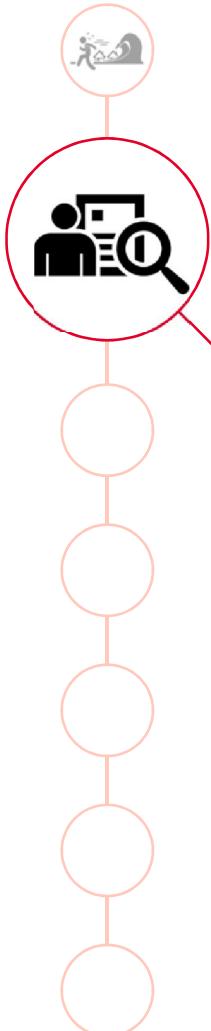


## Need Objective

Saving lives

Solving the issues related to flood

Finding opportunity for the new product development



## Research

# Problems

How ?

Equipment's

System

Activities

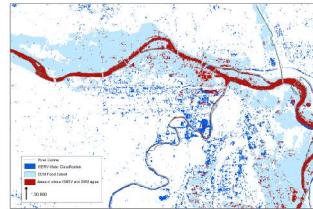




# Research System



## Flood estimation



Satellite Image  
study

Field observation



## Flood Evacuation

Department centric planning

Making online Inventory

Planning: Staff competency,  
Testing emergency operation

Coordination between  
institutes at state, district and  
national level



## Flood Response

Central Level

>

District Level

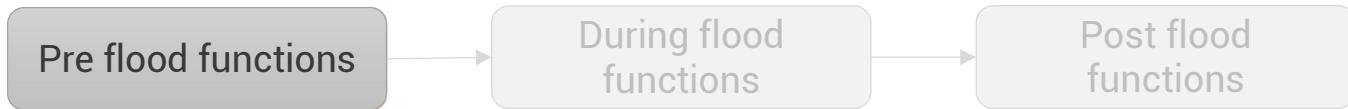
State Level



## Flood relief

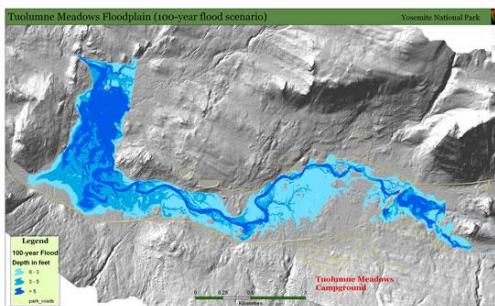


## Research Secondary



- Planning Emergency Relief by State Gov.
- Emergency Response team alerted
- Pre positioning

### 1. ICS (Incident Command System):



GIS maps



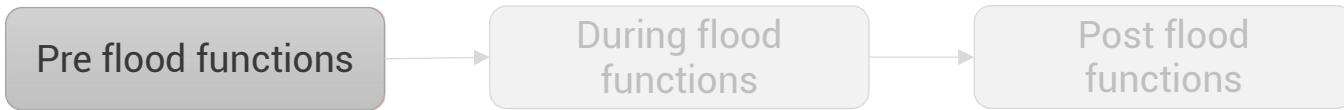
Simulation model



Scenario analysis



## Research Secondary



- Planning emergency relief by state gov.
- Emergency response team alerted
- Pre positioning

## 2. Alerting Response and Support teams:



First Responders: Locals  
(past 80% cases)



Secondary Responders:  
NDRF, IA, IAF, BSF



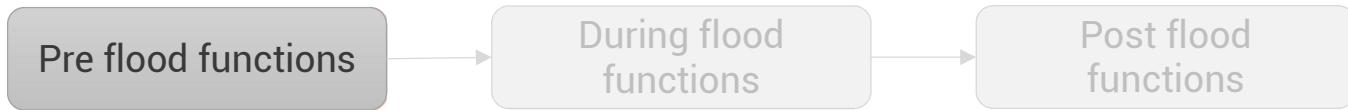
NDRF Assistance:  
ATIS, CD, Home guards, NGOs



Support Team:  
NCC, NSS (National service scheme)



## Research Secondary



- Planning Emergency Relief by State Gov.
- Emergency Response team alerted
- Pre positioning

### 3. Planning and Relief



Emergency shelters



Healthcare facilities



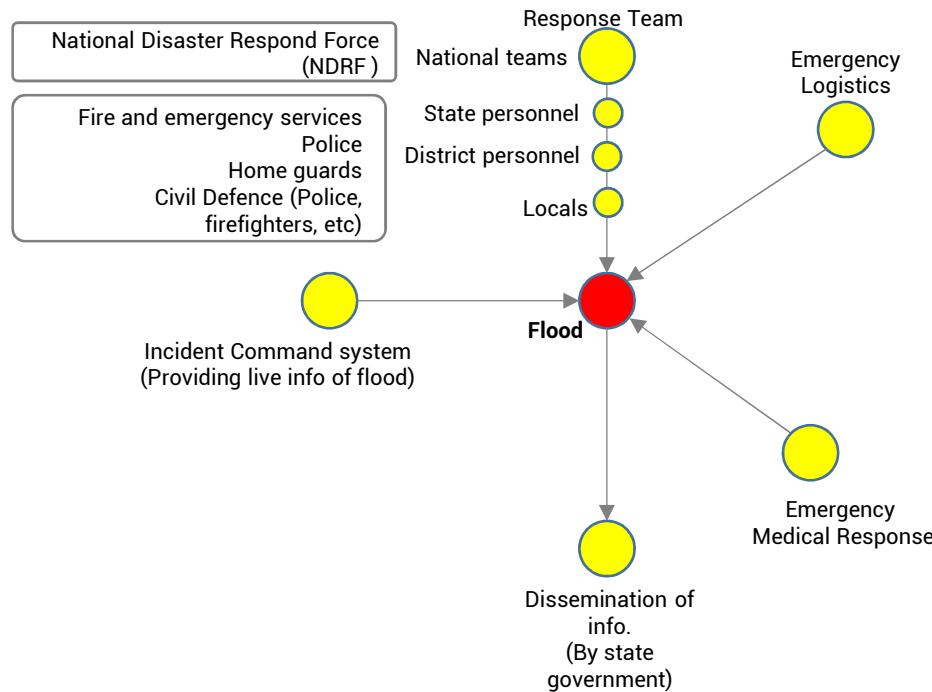
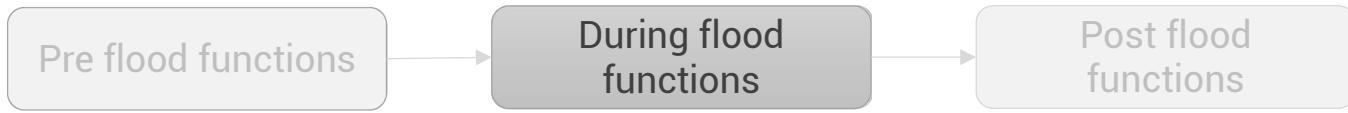
Water, food supply



Distributing Relief

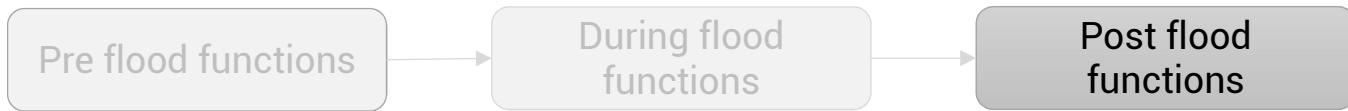


## Research Secondary





## Research Secondary



Relief Camp setup to provide shelter to those who fled their villages

### Operations:

- Mobilisation of relief supplies
- Tents
- Water supply
- Sanitation system
- Communication support
- Medical support



## Research Secondary



- More than **400 deaths** overall in the Kashmir region <sup>[6]</sup>
- Over **600,000 people** remained **stranded** in Kashmir Valley



## Research Secondary



Evacuation activity of women and the elderly from flood becomes difficult



difficulties in crossing river



Millions. Displaced, missing, starving



Jhelum river overflow



people got stuck because of high rise water



water overflows over bridges



## Research Secondary



Rescue activity by belongings



Problems of rescuing from 1<sup>st</sup> floor when water level is till first floor



Rescue activity by NDRF personals



Death due to cold water and hyperthermia



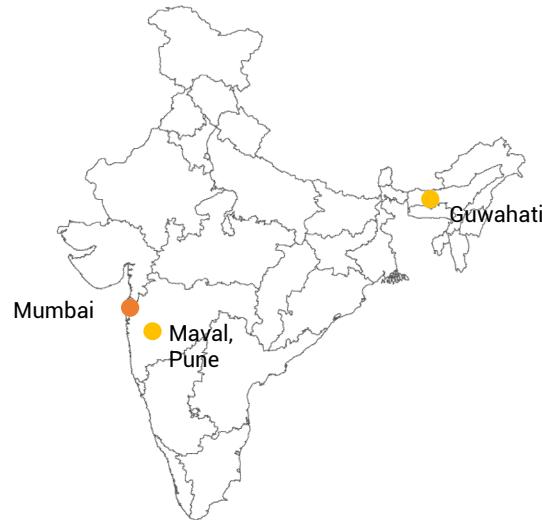
Dead bodies & animal carcasses are beginning to emerge



Airlifting in inaccessible areas



## Research field visit



### Locations visited (in order):

- 5<sup>th</sup> battalion, Talegaon (Maharashtra),
- 1<sup>st</sup> battalion, Azara, Guwahati (Assam)
- RRC (Regional Resource Centre) in Mumbai

### Purpose:

1. Know how of operation procedure
2. Understanding equipment and usage
3. Identifying problem areas
4. Documentation

### Methodology:

1. Photo Documentation of equipment
2. Interviews



## Research field visit

- Activities of NDRF personals

1. Rescue   2. Relief   3. Rehabilitation



*Basic Training and Specialised training*



*Community awareness programme*



*Study of Typology and Geography*



*Familiarization exercise, Mock drills*



*Pre-disaster posting*



*Operations*



# Research field visit

High value equipment's used by NDRF Personals - Boats/ Rafts:



Rubberised boat 25 to 75 HP OBM



Inflatable rescue raft



FRP boats (40 HP motor, carrying capacity: 30 people, Need to be transported in trucks)

Life saving equipment's



Life buoys



Life Jackets

Other equipment:



Diving Suit



ASKA light tower



Portable oxygen unit



## Research field visit

- **Improvised Floating Devices**



*Water bottle vest*



*Coconut shell vest*



*Matka and tin-can floating units*



*Basketball*



*Plastic pots*



*Plastic pots*



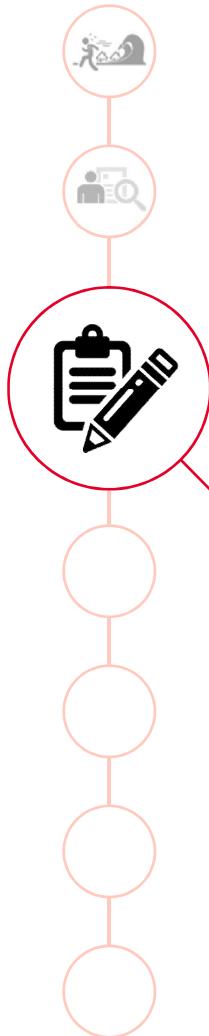
*Thermocol units*



# Research field visit

- Chart representation comparison of various flotation devices and boats

Factors	Rubber Raft (Circular)	Inflatable Boat (OBM)	FRP Boat	Banana boat	Improvised (Single person unit)	Bamboo Raft
image						
Structure	Tubular	Tubular + Al chanel + Plywood	bowl type	Banana tree + wooden bed	Flexible + tied	Modular + tied
Types	Close	Open	Open	Open	Vest	Flat bed
Material(s)	Hypalon/neoprene, PVC or Poly urethane	Rubber coated Fabric, Nylon Reinforced Hypalon	FRP Boat	Banana tree	Coconut shell/ Pl. Bottle / tin-can	Bamboo
Auto deployment	Yes	Yes	No	No	No	No
Maintenance	Semi skilled	Skilled people	Skilled people	Semi skilled	Semi skilled	Semi skilled
Indication	Light on top + reflectors + orange color	Bright Colours	Bright Colours	None	None	None
Depth of water req. to float	1-2 feet	2-3 Ft	2-3 ft	0 - 1 feet	0 - 1 feet	0-1 feet
Capacity (People)	25 people	07-10 people 800kg	12 (1200KG)	Non standard		1 Non standard
Safety features	One way valve + multi compartments	1 way valve, provided with bow storage bag and safety kit	remote control steering	always floating	always floating	always floating
No. of people to drive	2 (pedaling)	1	1	1 (pedaling)	1 (pedaling)	1 (pedaling)
Weight	less tha 100 kg	Drt wt. 75 kg (w/o OBM)	350 kg (w/o OBM)	Non standard	less than 2 kg	Non standard
Size (lbh)	64'Hx25'Lx23"W	4200X1800X1000 19' tube dia	15ft X 6ft X 2.5ft	Non standard		Non standard
Cost	4.5 lacs	3.14 lacs	4.11 lacs			
Packaging	Foldable	Foldable	non foldable	Non foldable	Foldable	Non foldable
Transportation	By air/ trucks	Truck	Truck	Manual lifting/ trucks/ air	Manual lifting	Manual lifting
Power source	Human powered	Motor - 25HP	motor - 40HP	Human powered	Human powered	Human powered



## Design Brief



## Design Brief – Direction

### **Design Directions**

Problems and Issues which are critical

1. Being Prepared for the situation
2. Quantity of the safety equipment's
3. Safety in water (flow, depth, snakebites)
4. Direction (navigation) and search for the safe place
5. Provision of water, food and medicine
6. Safety of belongings



## Design Brief – Direction

*“To Design a victim centric, portable, self rescue kit for an individual, in urban flood scenario which will allow person to float, move in still water and also will protect from flash floods”*

### **Basic specification**

Capacity - 1 person (120 kg max)

Users male/female

weight – should less than 5 kg

Min life span- approx. 5 years

### **Important**

Portable

protection from rain

Quickly deployable within 1 min

Keeping person dry

Indication to the rescuers

### **Critical**

Floating

Prevention from toppling

Protection from debris

Easy to use even by the illiterate

Prevention from drifting away

### **Desirable**

Reusable

Navigation aid

Night rescue assistance

Owned by the people



## Design Brief – Direction

Rescue from home



Broken glass on wall



Barbed wire



Wall railings

Navigation



Fast flowing water



Whirlpool



Open Manholes

Dangers



Parked cars



Electricity wire



Snake



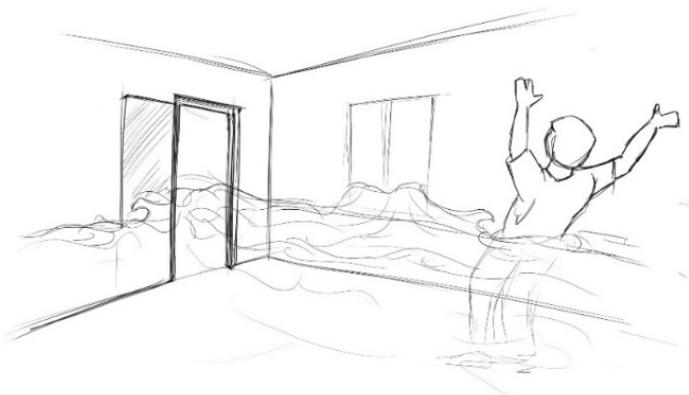
Debris



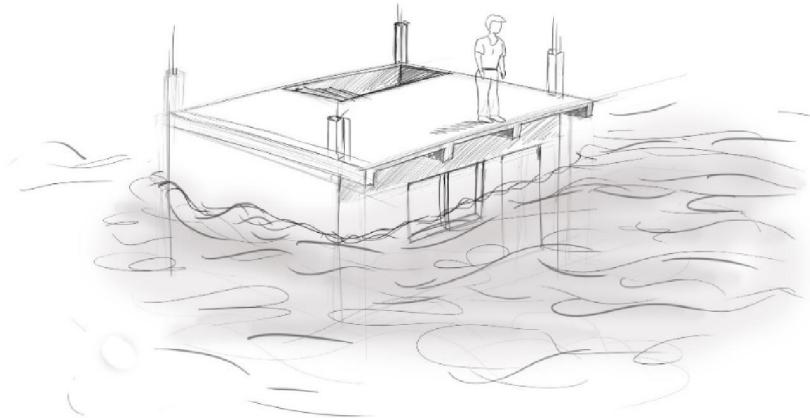
## Design Brief – Direction



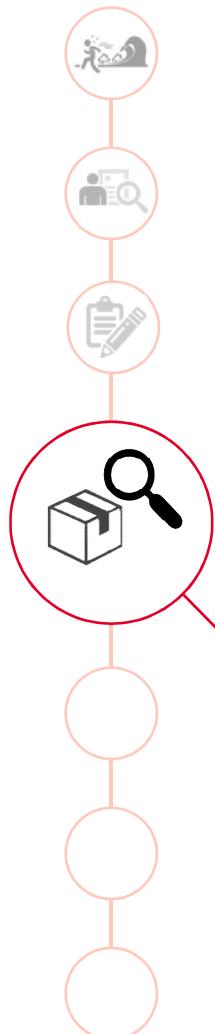
Situation 1 : rescue possible only through window



Situation 3 : when water starts rushing into the house



Situation 2 : rescue possible from roof top



Design  
materials  
Structure  
detailed  
Product study





## Product study – flotation devices

### EVA foam floats



A standard EVA foam kickboard

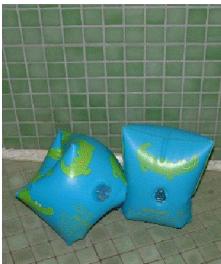


Waist belt



Foam Grip Pull Buoy

### Air filled floats



arm bands



Ring buoy



air filled life jacket



Kerala's traditional circular boat - Coracle



Indian Small Boat



## Product study – flotation devices

### Amusement Park floating devices



Swimming Pool Chairs



inflatable pool float



buoyant pad



IR-17



Swimming Pool Chairs



## Product study – flotation devices



Stretcher with foam material for buoyancy

### Stretchers

for patient transfer from water

The tubular structure is used to increase the strength and foam floats or inflatables are used to keep stretcher floating.



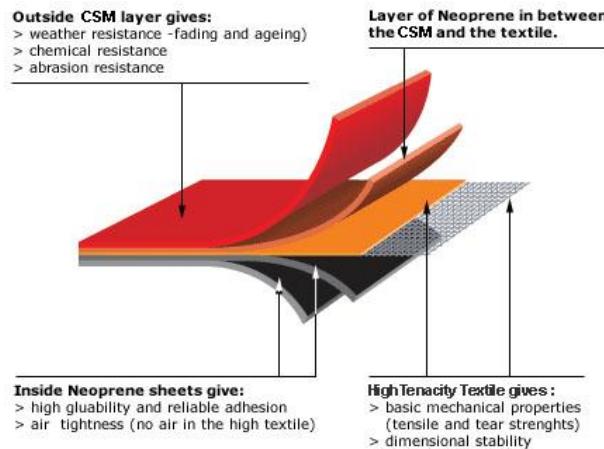
Stretcher with inflatable tubes



## Product study – Material



rubberised inflatable boat



**Outside CSM layer gives:**  
> weather resistance -fading and ageing)  
> chemical resistance  
> abrasion resistance

**Layer of Neoprene in between the CSM and the textile.**

**Inside Neoprene sheets give:**  
> high glubility and reliable adhesion  
> air tightness (no air in the high textile)

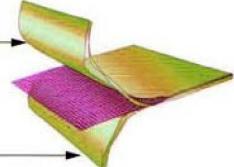
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### PVC COATED FABRIC:

0.9mm, 1100 Denier polyester fabric which has been specially coated on both sides with PVC.

#### Features:

- Outside PVC layer offers:  
Abrasion resistance;  
Extreme condition resistance;  
Chemical resistance.



- Inside high polyester fabric offers:  
Dimensional stability;  
Tensile and tear strength.



#### Points of making

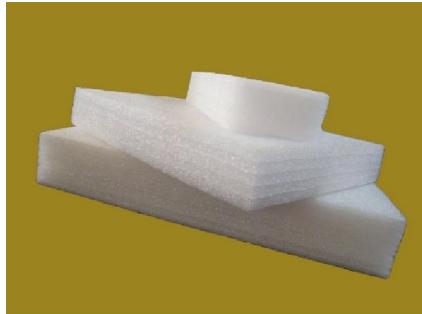
- Adhesive structure
- Polyurethane glue
- Cold welding
- Made by hand
- Four layers reinforced seams.



kickboards



## Product study – Material



EPE foam in different shapes



Thermocol

### **EPE Foam (expanded polyethylene)**

- Waterproof
- buoyancy: up to 50 times lighter than water
- inert: resists to organic solvents and numerous chemicals
- non toxic
- easy to cut by hot wiring or sawing
- complex shaping using moulds

### **EPS (Expanded Polystyrene) thermocol**

- lightweight material which floats (density 150-400 kg/m<sup>3</sup>)
- excellent mass to volume ratio
- excellent thermal and acoustic insulation
- excellent mechanical properties (strength, damping)
- waterproof and mold resistant
- non-toxic (no CFCs)
- versatile and easy to shape
- best price/performance ratio than most construction materials



## Product study – Life jackets



Inflatable Life jacket before and after inflation



CO2 Cylinders used in life jacket for Inflation



valve arrangement for CO<sub>2</sub> cylinder



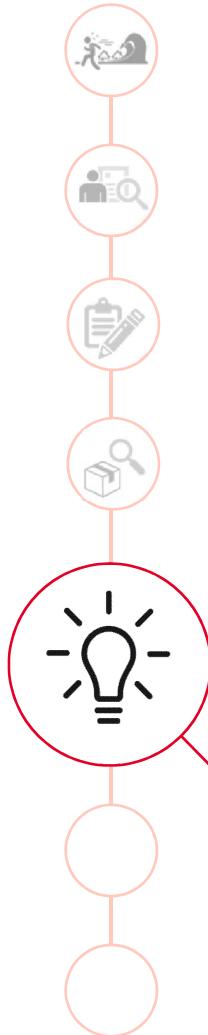
### Off-shore Life Jacket

- 22 pounds of buoyancy.
- Inflatable and Inherently buoyant types.
- Used for Open, rough, or remote water, where rescue may be slow in coming.

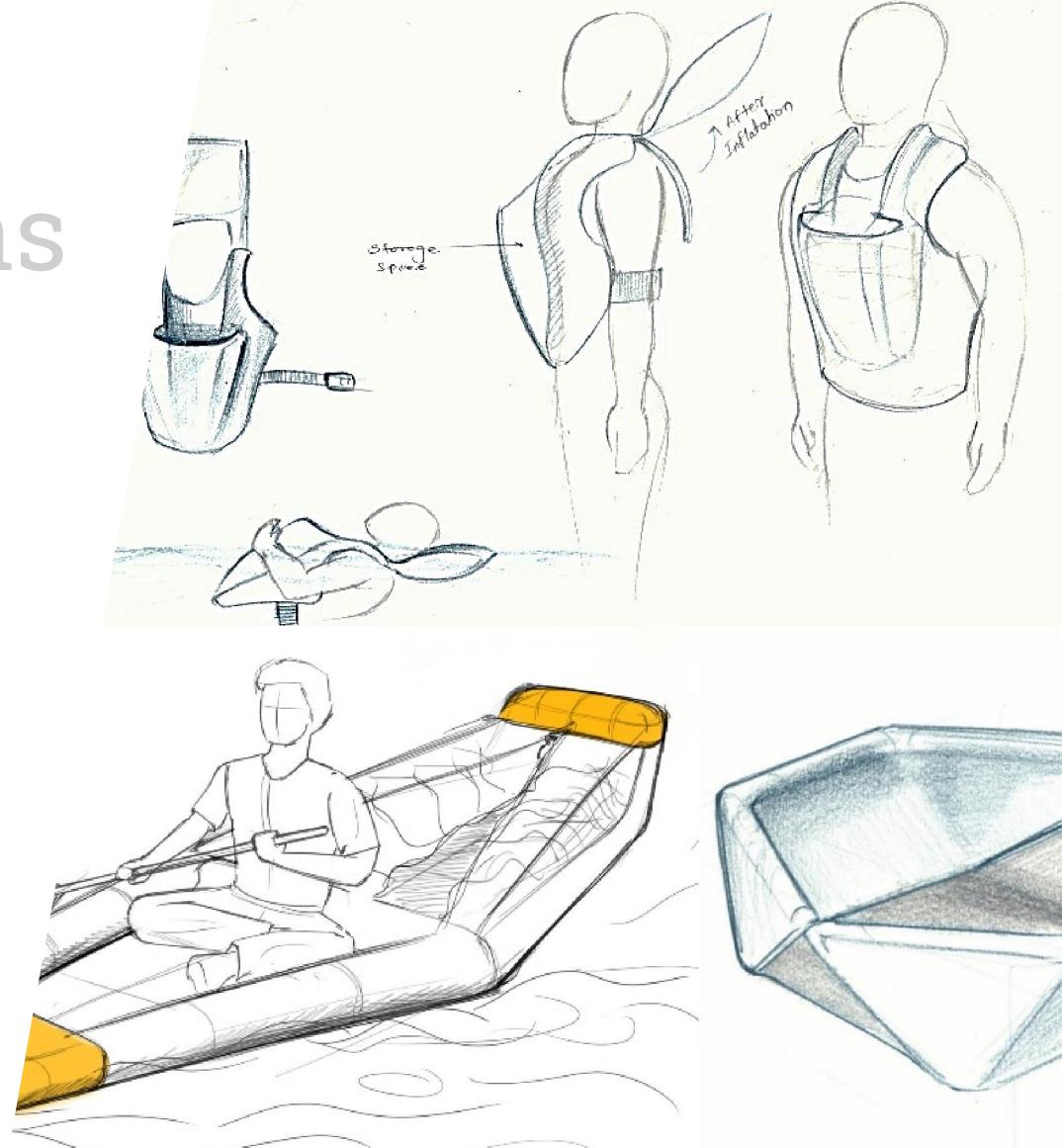


### Near-shore Buoyant Vest

- 15.5 pounds of buoyancy.
- Inflatable and Inherently buoyant types.
- Good for calm, inland water, or where you have a good chance of a fast rescue.

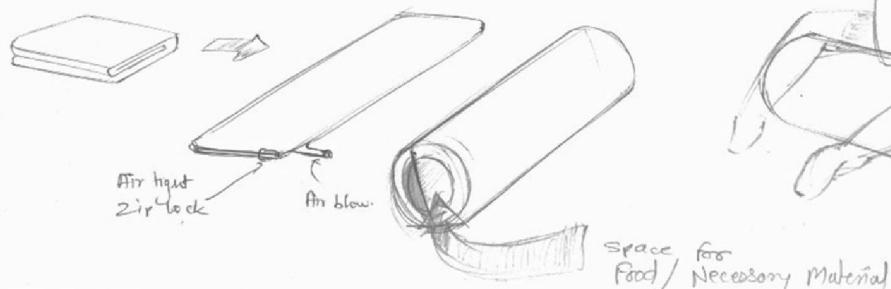
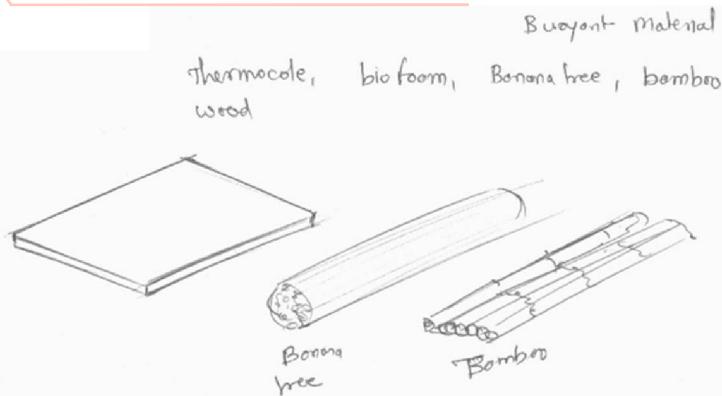


Ideations  
Mock-ups  
Doodles  
Concepts  
Illustrations





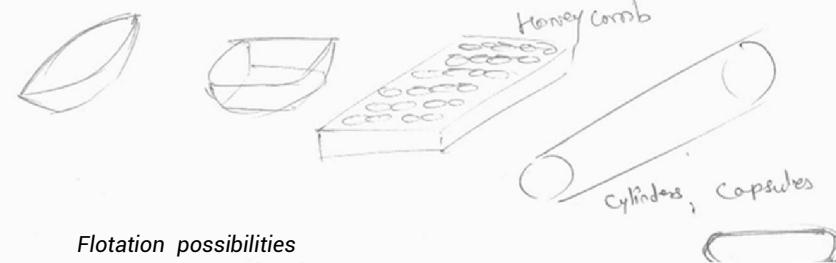
## Concept – Doodles



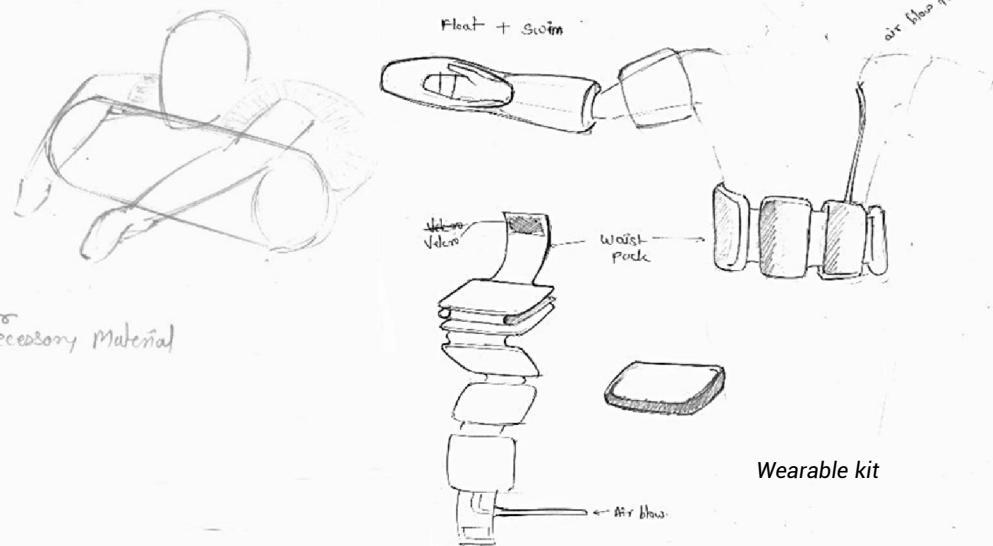
Kit that will store your valuables

Non buoyant material

metals, rubber

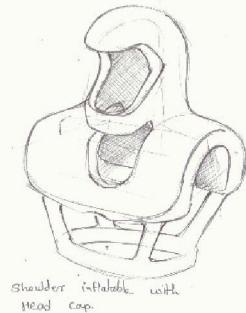


Flotation possibilities

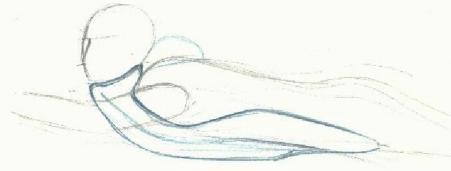




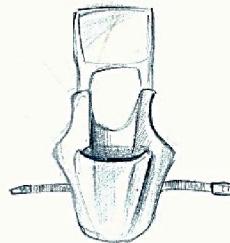
## Concept – Doodles



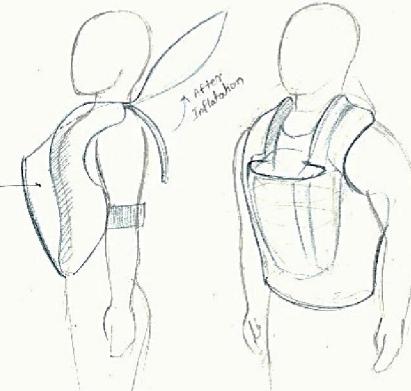
Shoulder inflatable with head cap.



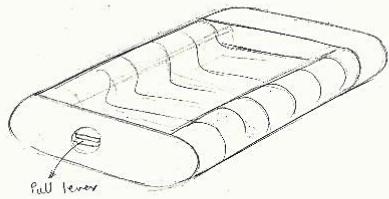
Chest Surf



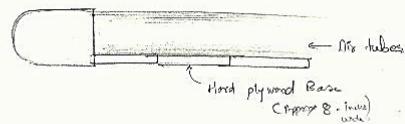
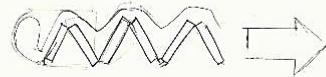
Storage space



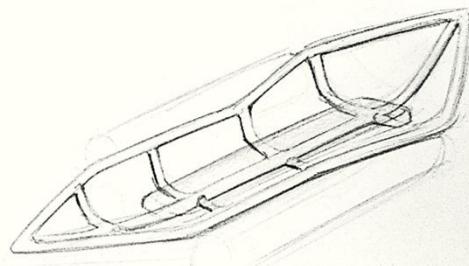
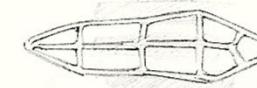
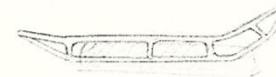
Scenario



Pull lever

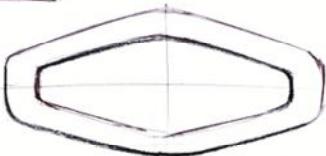
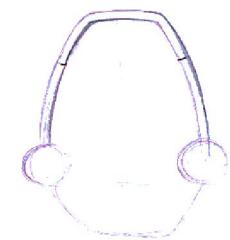
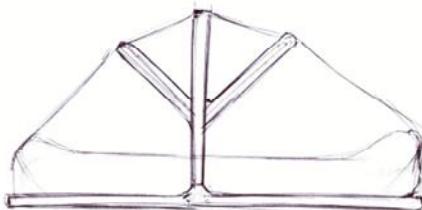
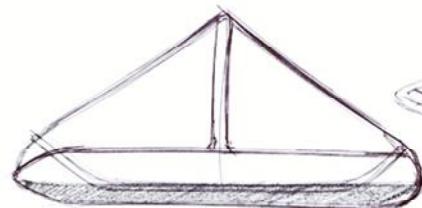
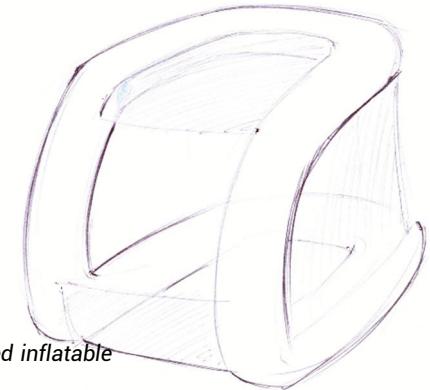
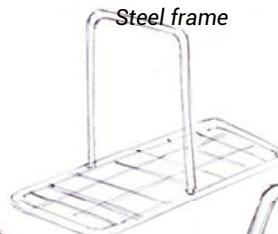
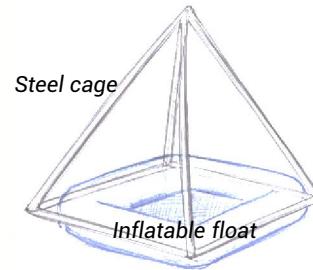


Air tubes  
Hard plenum base  
(approx 8 - in) wide



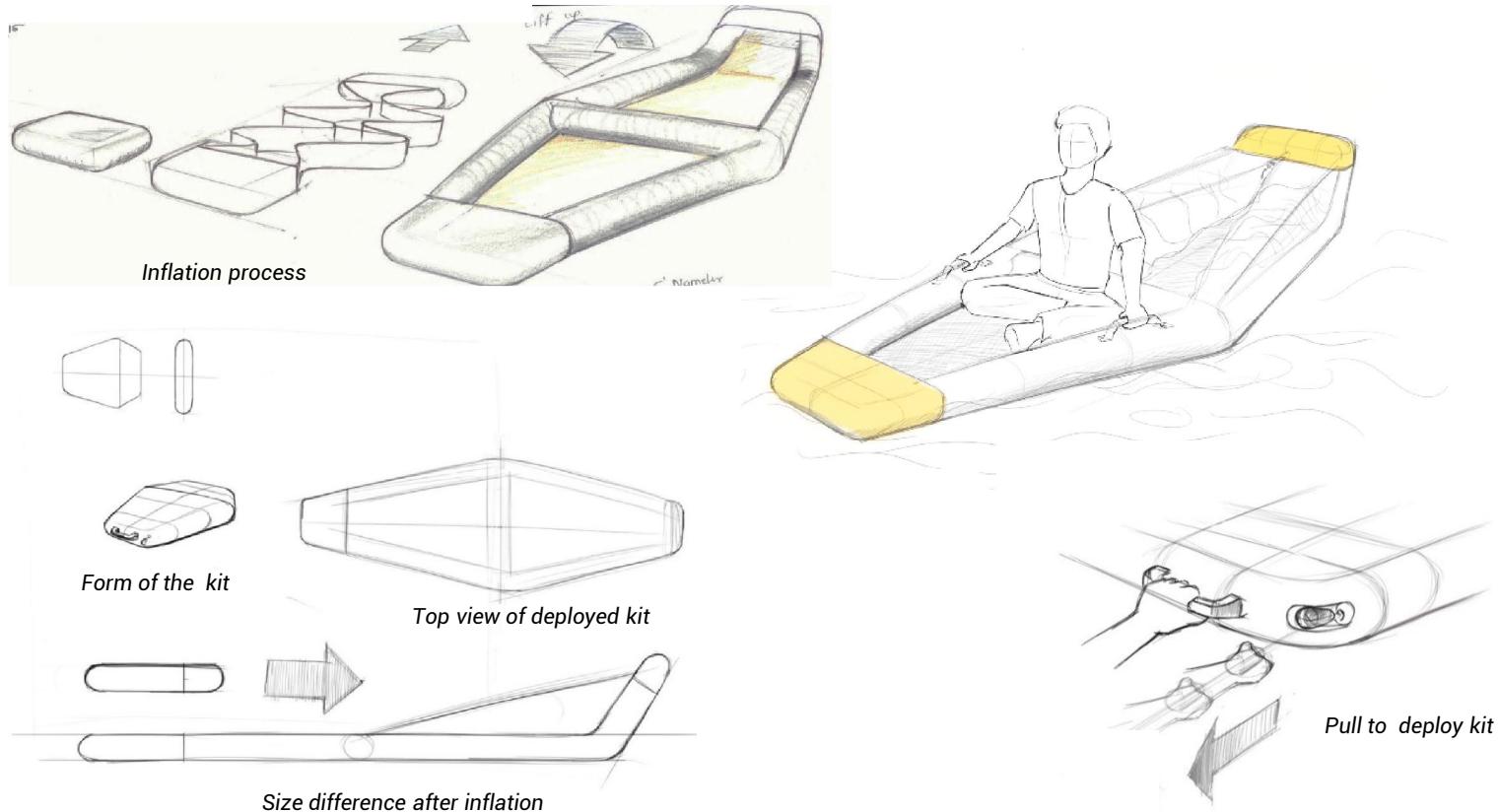


## Concept – Doodles





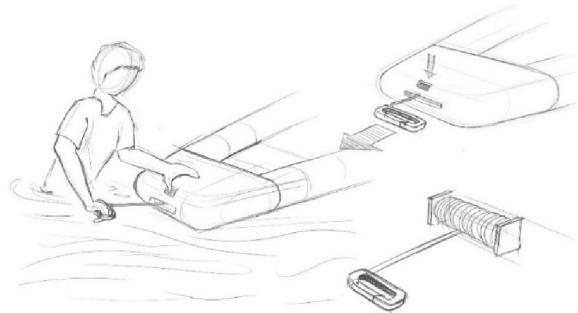
## Concept – Foldable roof





## Concept – Foldable roof

### Activity



*Hook arrangement for anchoring*



*Both directional mobility*

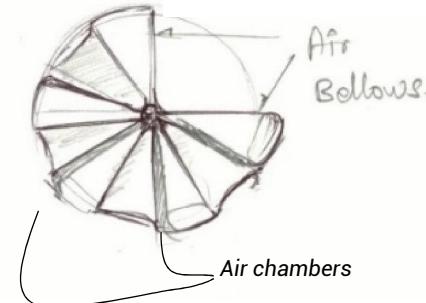
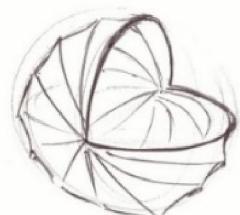
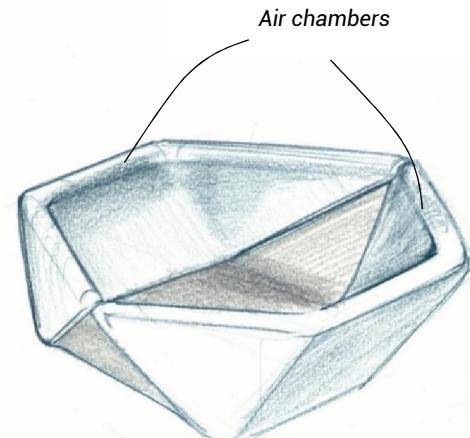
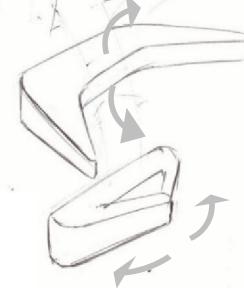
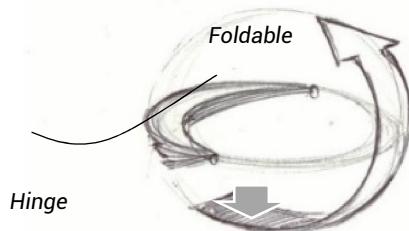
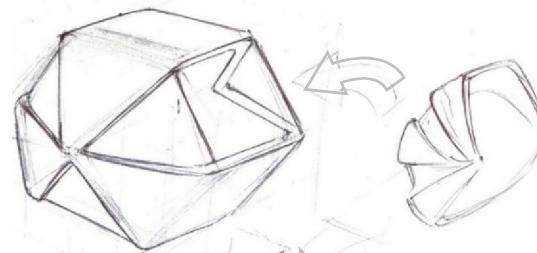


*Foldable rain cover*



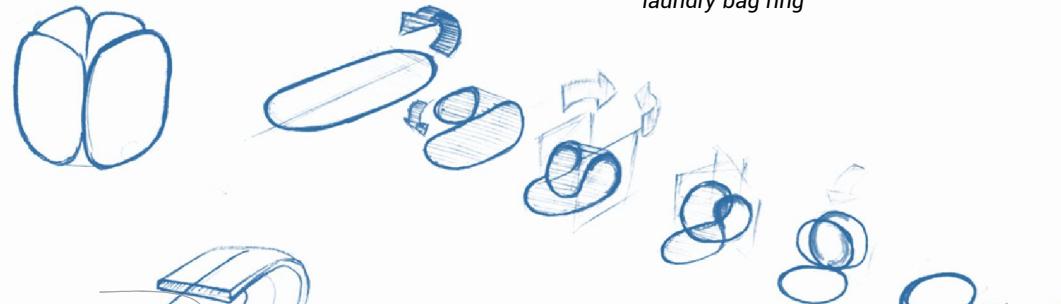


## Concept – Hexagonal inflatable floating device





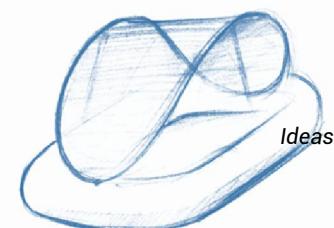
## Concept – Hexagonal inflatable floating device



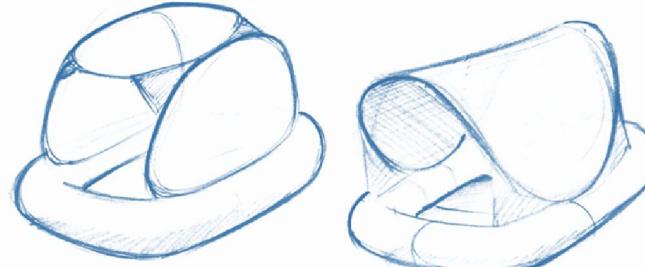
Stepwise folding process of laundry bag ring



Cross-section of the spring  
use din laundry bag for  
collapsibility

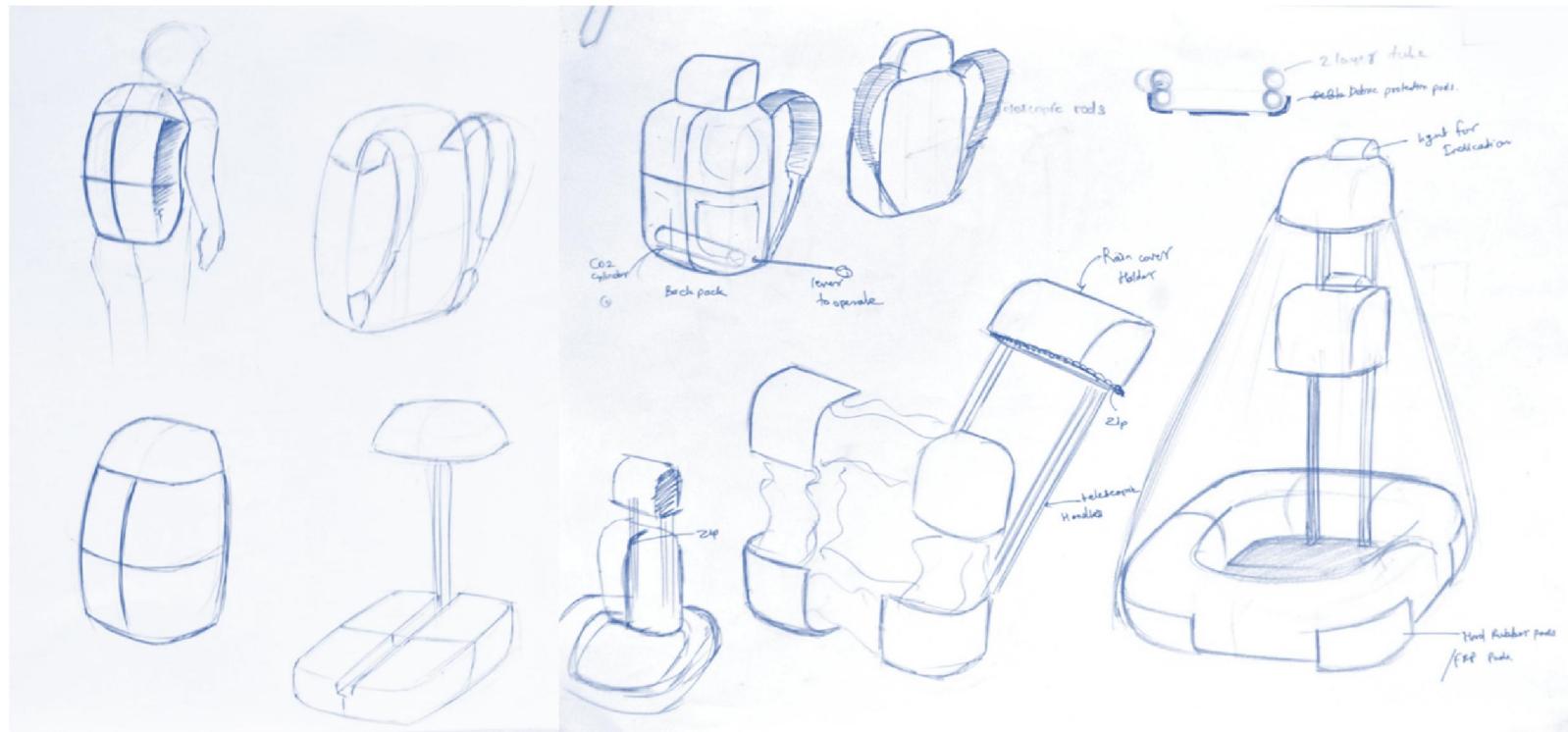


Ideas





## Concept – Backpack folding device

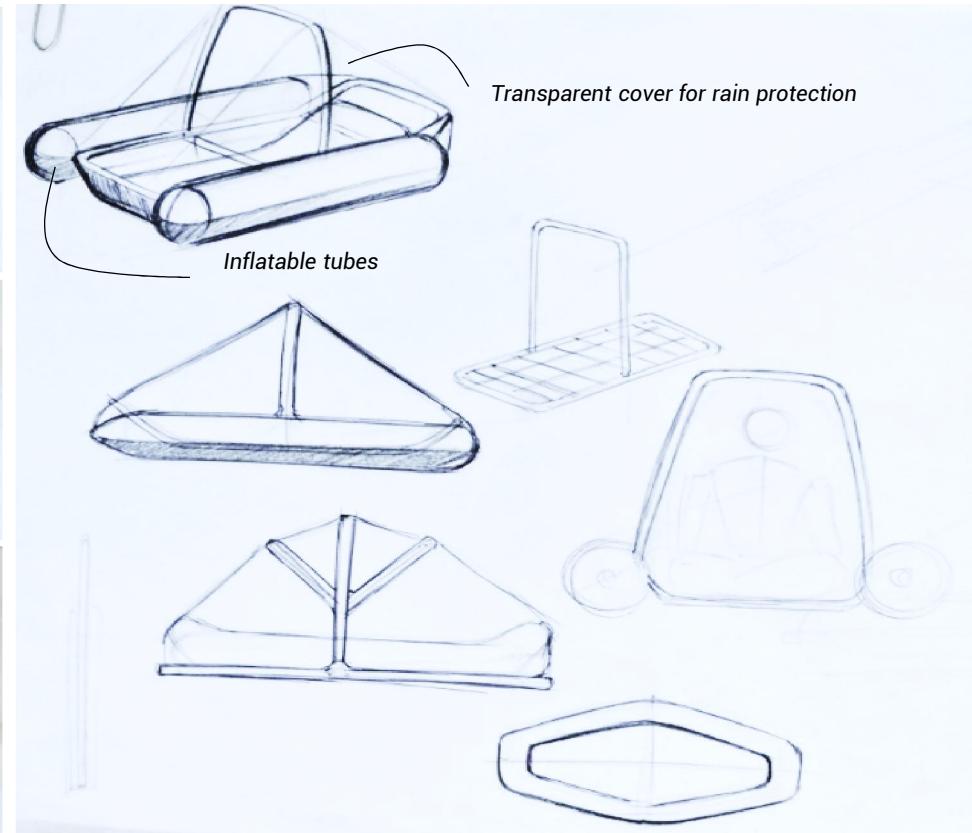




## Concept – Inflatable with tubular frame



Inflatable tubular tent

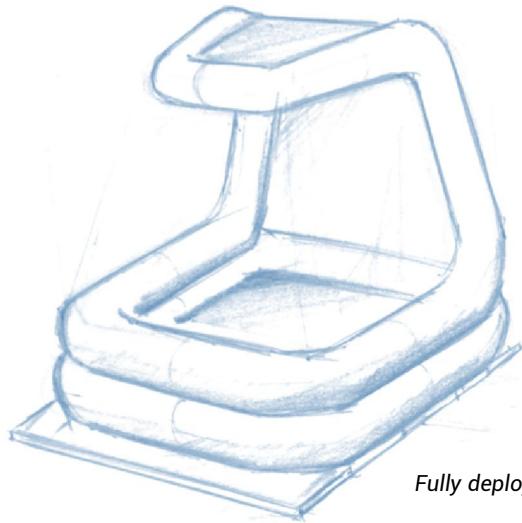


*Transparent cover for rain protection*

*Inflatable tubes*



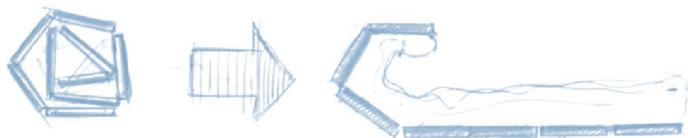
## Concept – Inflatable roof concept



*Fully deployed kit*



*Top view*

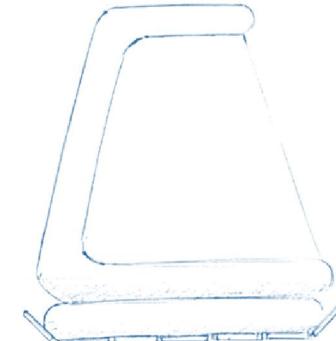


*Wooden planks in rolled form*

*Unrolling of wooden planks*



*Inflation of rubber tubes*

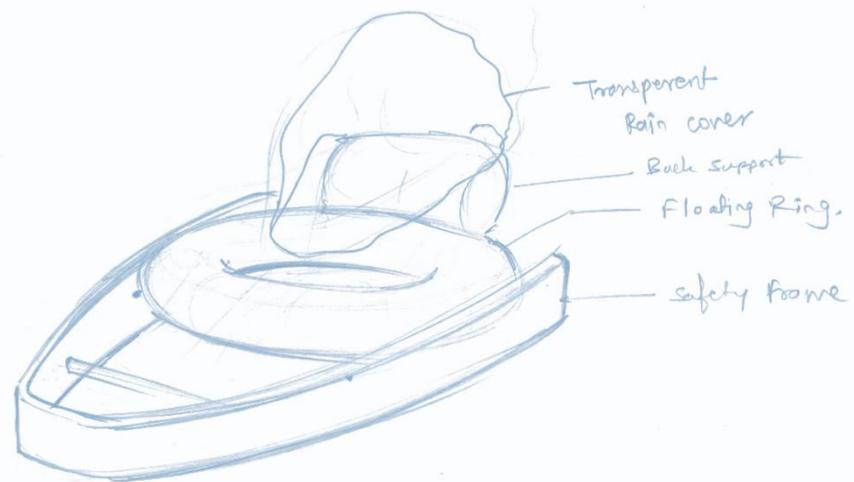
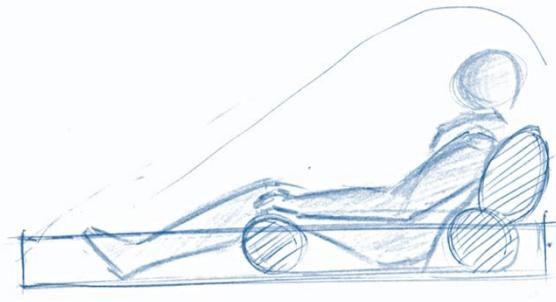


*Inflatable tubes*



## Concept – Inflatable with rigid frame

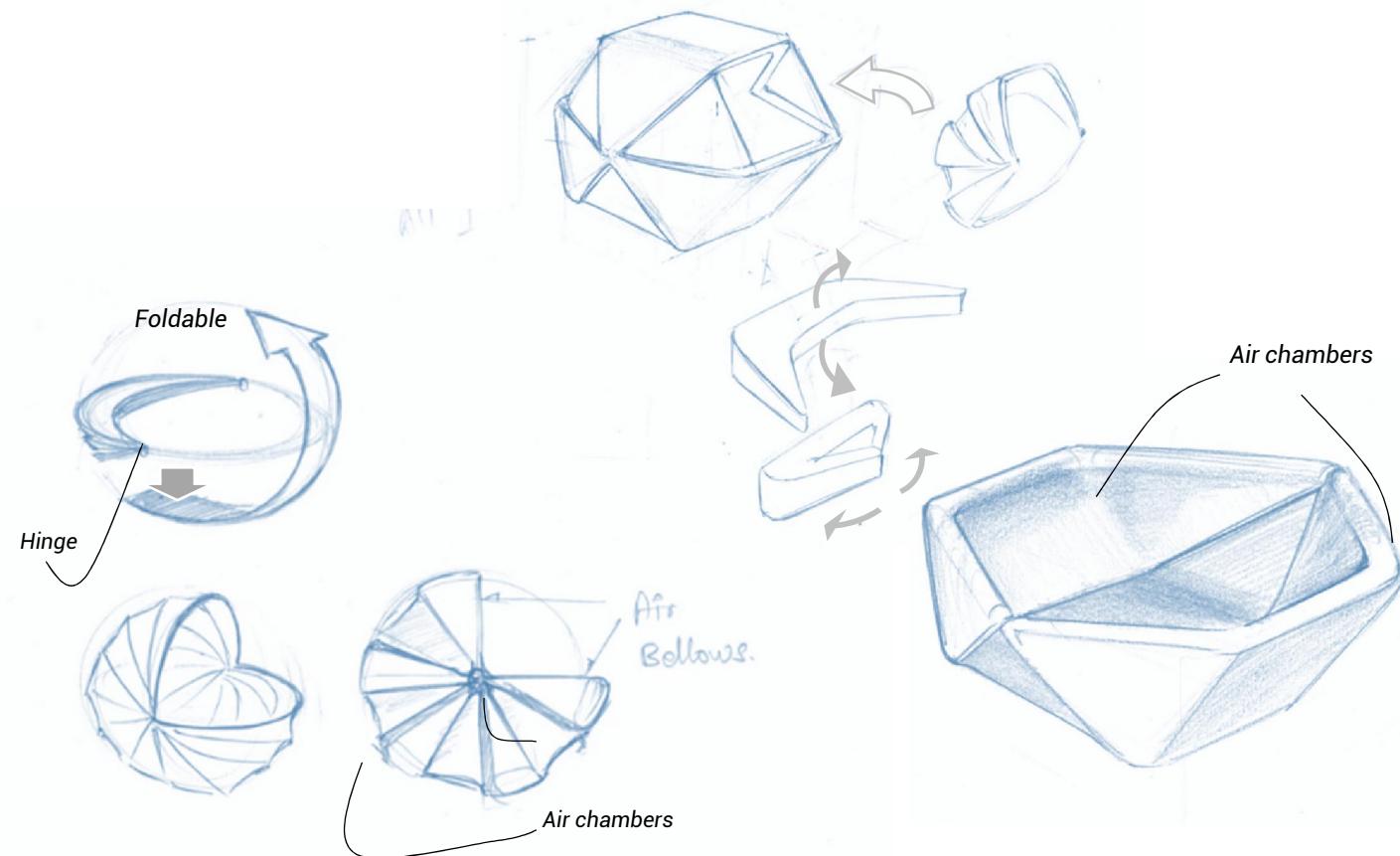
Inspiration : swimming pool hair headphones





## Concept – Concept 1

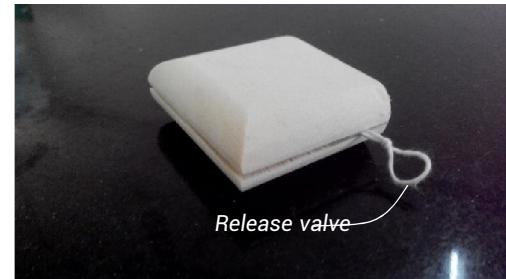
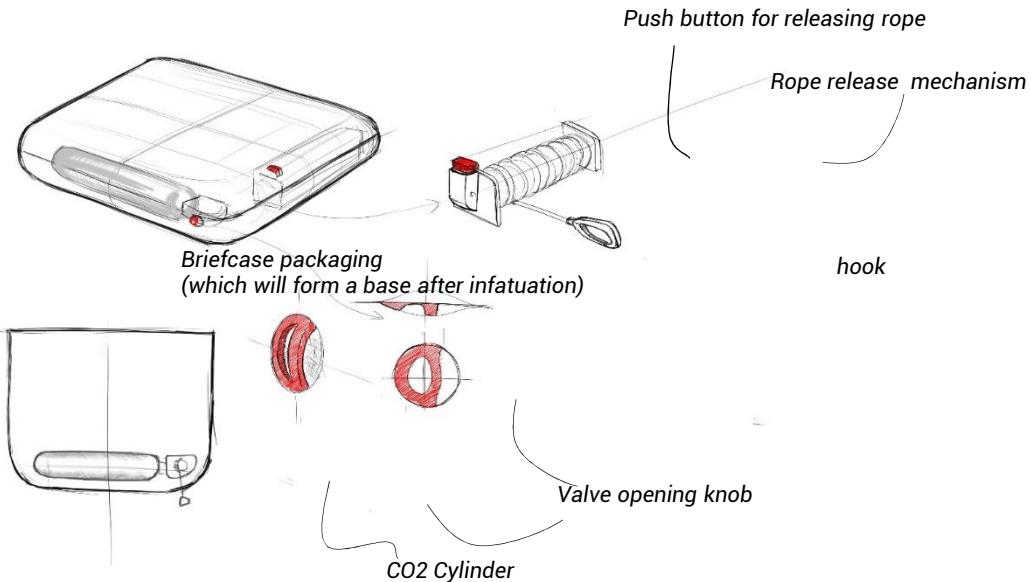
### Hexagonal inflatable





## Concept – Concept 1

### Hexagonal inflatable





## Concept – Concept 1

### Hexagonal inflatable

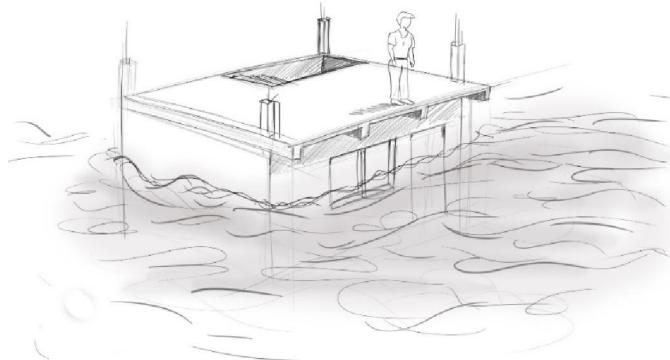


Situation 1 : rescue possible only through window

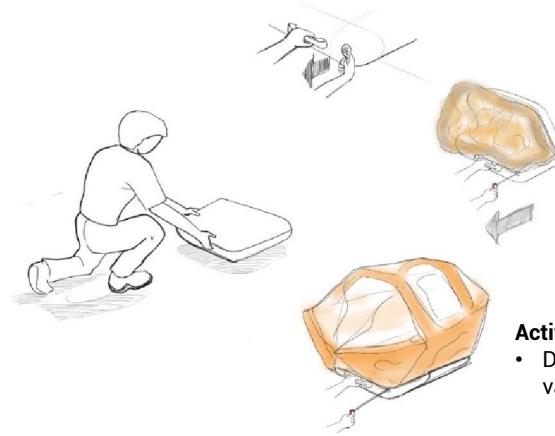


#### Activity:

- Tie kit rope to the strong structural member
- Deploy kit outside the house when water level is near to the window sill



Situation 2 : rescue possible from roof top



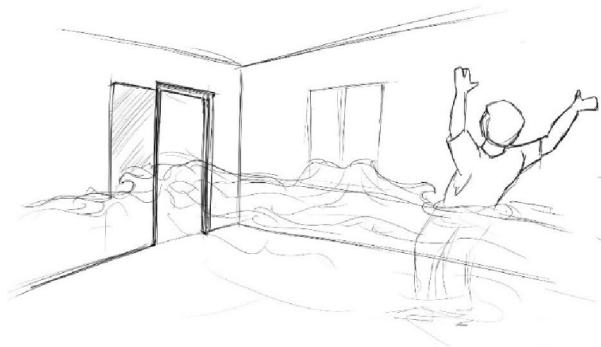
#### Activity:

- Deploy kit by pulling valve knob

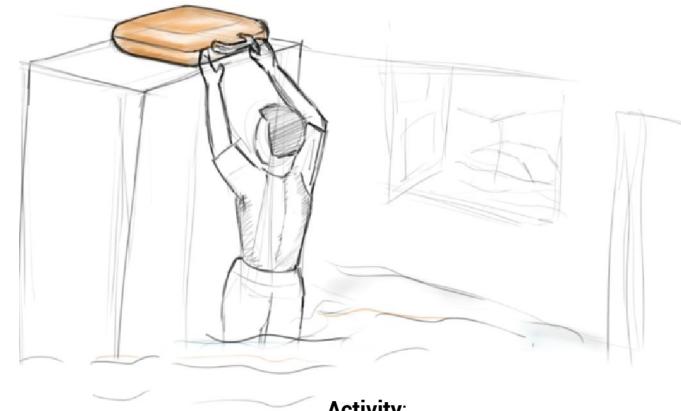


## Concept – Concept 1

### Hexagonal inflatable



Situation 3 : when water starts rushing into the house



#### Activity:

- Deploy the kit outside the house as soon as possible



## Concept – Concept 1

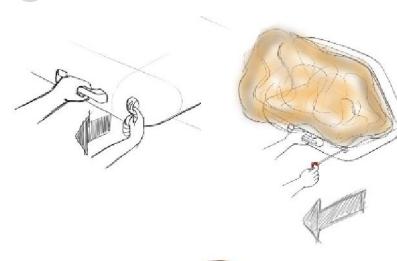
### Hexagonal inflatable

- 1 Tie rope of the kit to the safe place with the help of hook



- Illustration of activity of deployment of kit

- 2 Release the knob by pulling it



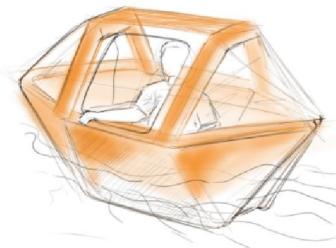
- 3 Pull out the kit with rope



- 4 Slide in to the kit



- 5 Turn around to get in



- 6 Zip on to close rain protection cover



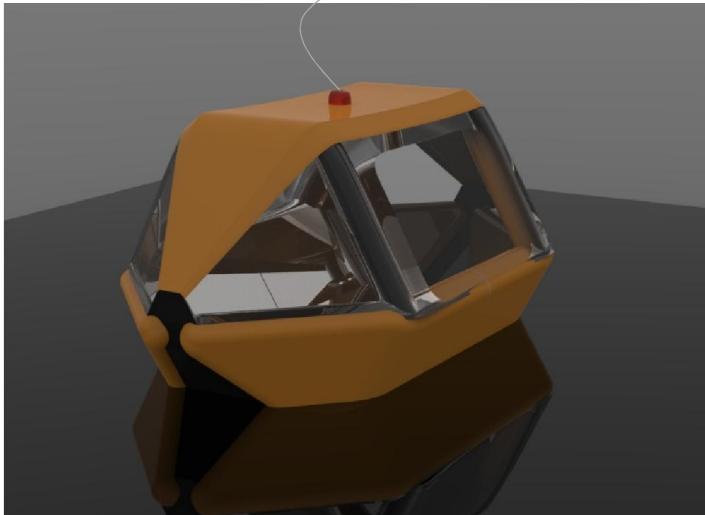
- 7 Mobility with the help of pedals



## Concept – Concept 1

### Hexagonal inflatable

Light for indication to NDRF

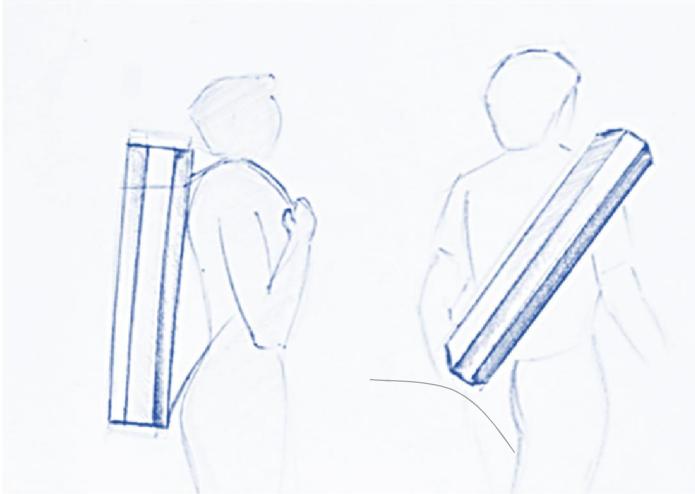


- Digital model

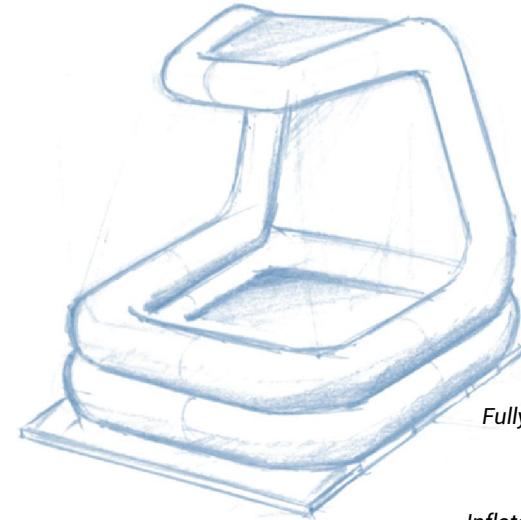


## Concept – Concept 2

### Inflatable with wooden base

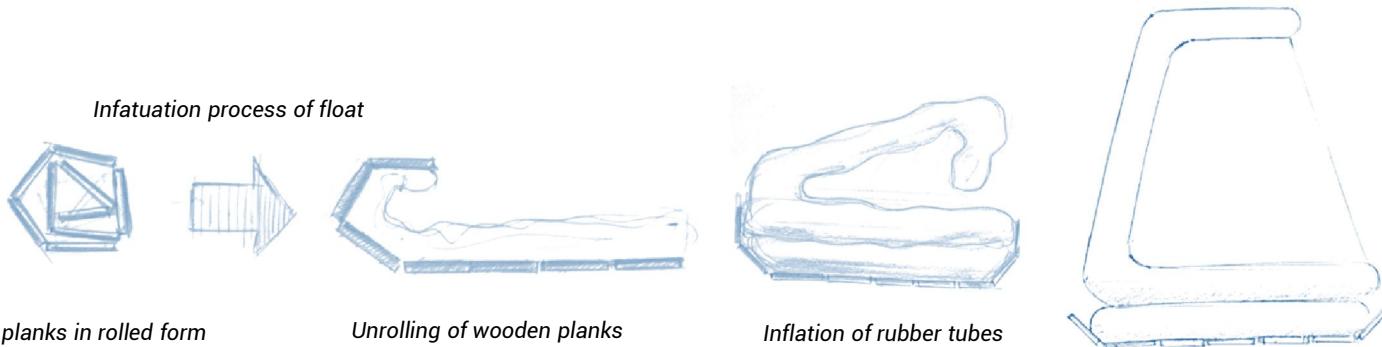


*Kit in folded form*



*Fully deployed kit*

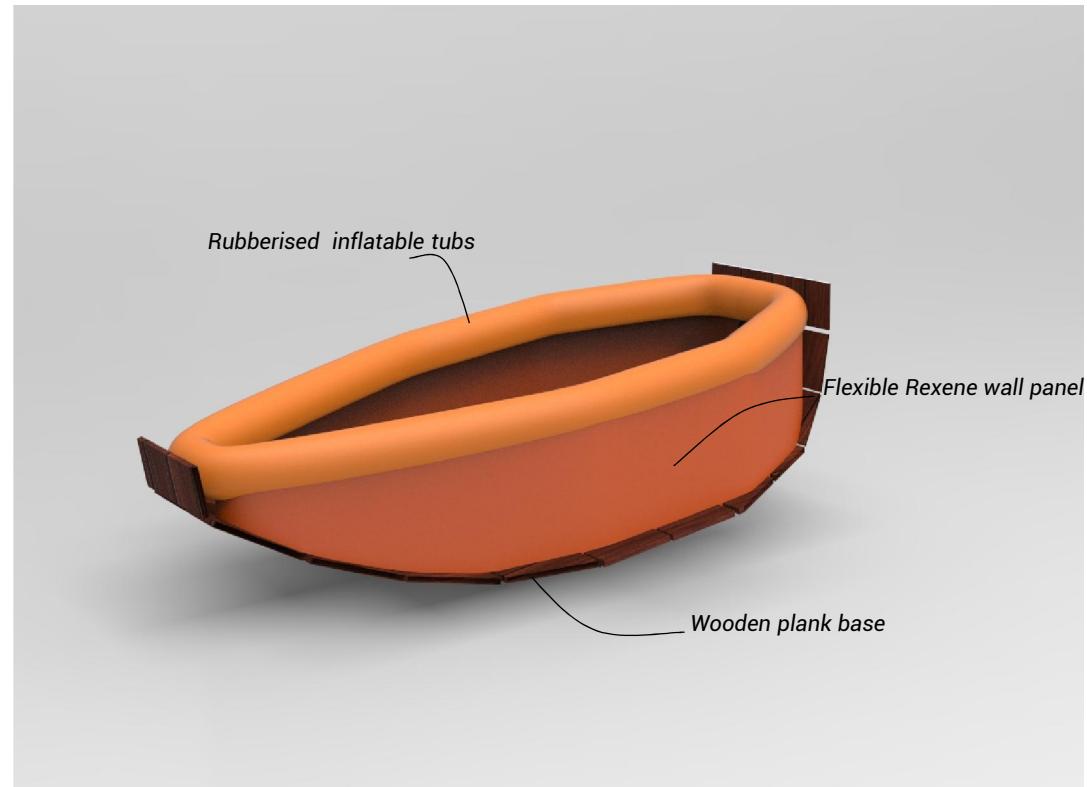
*Inflatable tubes*





## Concept – Concept 2

Inflatable with wooden base



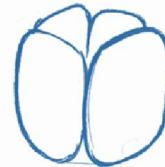


## Concept – Concept 3

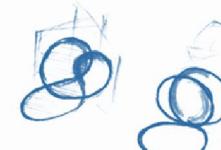
Collapsible



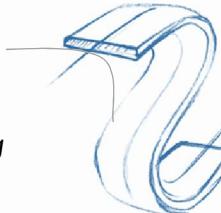
Laundry bag



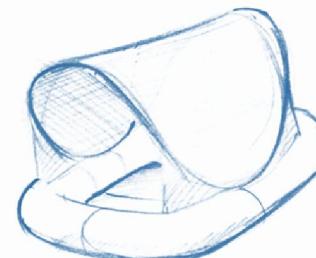
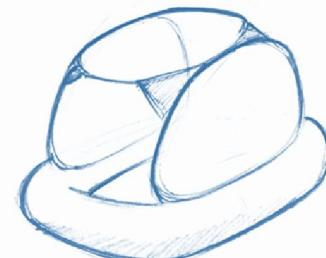
Stepwise folding  
process of laundry bag  
ring



3 layers



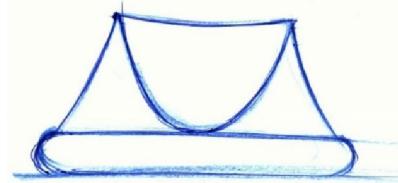
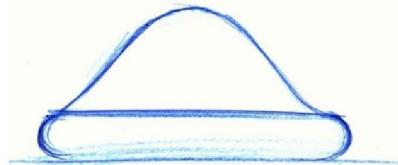
Cross-section of the  
spring use din laundry  
bag for collapsibility



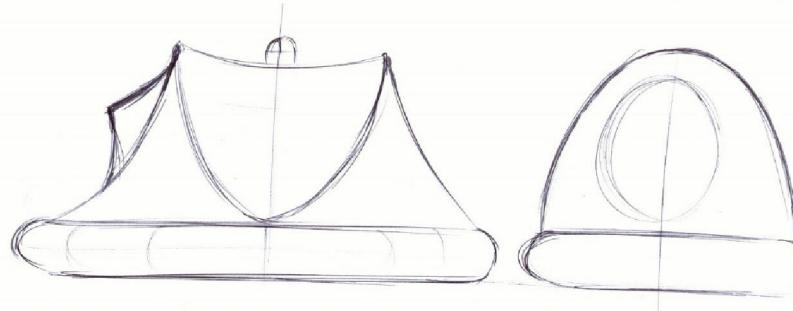
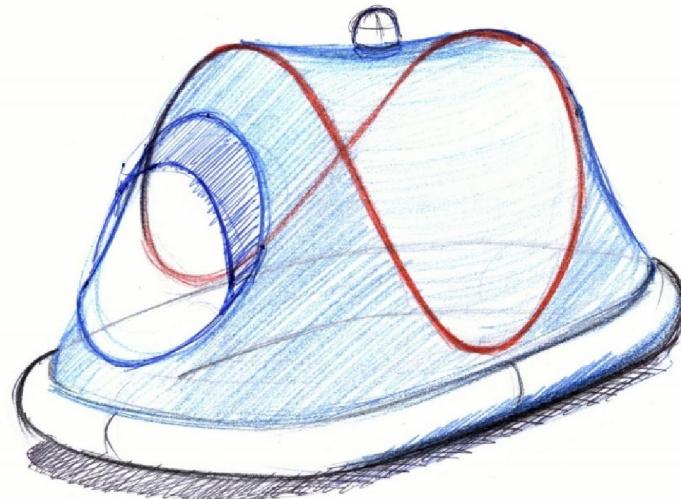
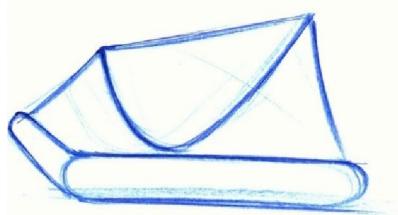
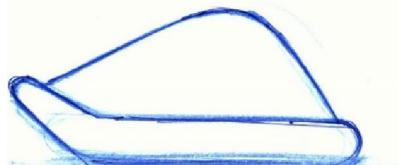


## Concept – Concept 3

Collapsible



Variations





## Concept – Concept 3

Collapsible



Digital models



Physical mock-up model



## Concept – Feedback NDRF, pune



NDRF Personals attending presentation

### Issues to be addressed critically

1. Toppling of kit during ingress and egress
2. Strength of the anchoring rope
3. Cost of the product should be minimum
4. Protection from debris and harmful objects in water is essential.
5. Demonstration and activity or stepwise procedure need to be explained.
6. Building confidence and trust is important.

### Suggestions

1. Installation of a sensor which will activate when the kit is deployed
2. Night rescue possibilities
3. Manual pump for inflation
4. Hard base will be a better idea for debris protection



## Concept – Feedback NDRF, pune

- **Insights**

1. People in Assam prepare themselves for flood (by learning swimming, making Improvised Flotation Device's).
2. They also experiments with different floatation devices at their own. There is a definite need.
3. Life jacket is not very helpful in flood situations.
4. Elderly must have dry kit.
5. Majorly it will help elderly a lot who don't know how to swim.

- **Good points**

1. Its an very innovative concepts
2. It will give relief to use also
3. People in Assam makes improvised floatation devise at their home. They will definitely use such kind if kits
4. Will be very helpful in scenarios like Kashmir
5. Idea of whistle and Overhead light is very good to identify



## Concept – Feedback stage 3

- Ingress and egress into the kit when it is deployed is very difficult.
- Stability wont be there in flood water.
- There are no constraints in the design brief in terms, its open ended.
- Jumping into the kit will not be possible

- **Suggestions:**

- Make it wearable and attached to the body while getting into the water.
- Focus primarily on keeping persona alive.



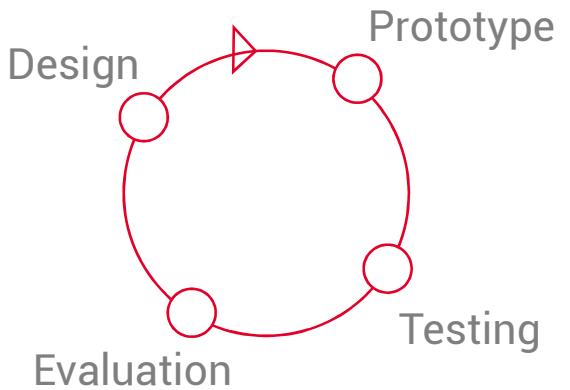
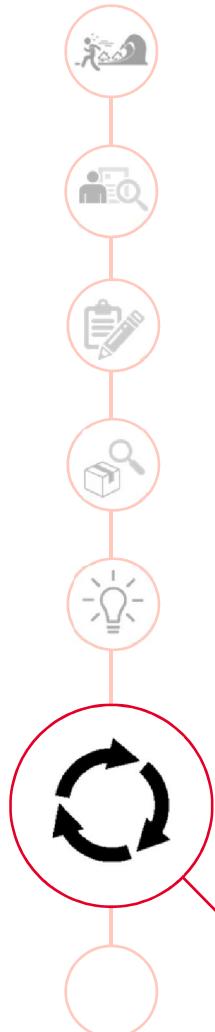
## Concept – redefined design brief

### Objective

Design of a victim centric **self rescue kit** for an individual in urban flood scenario

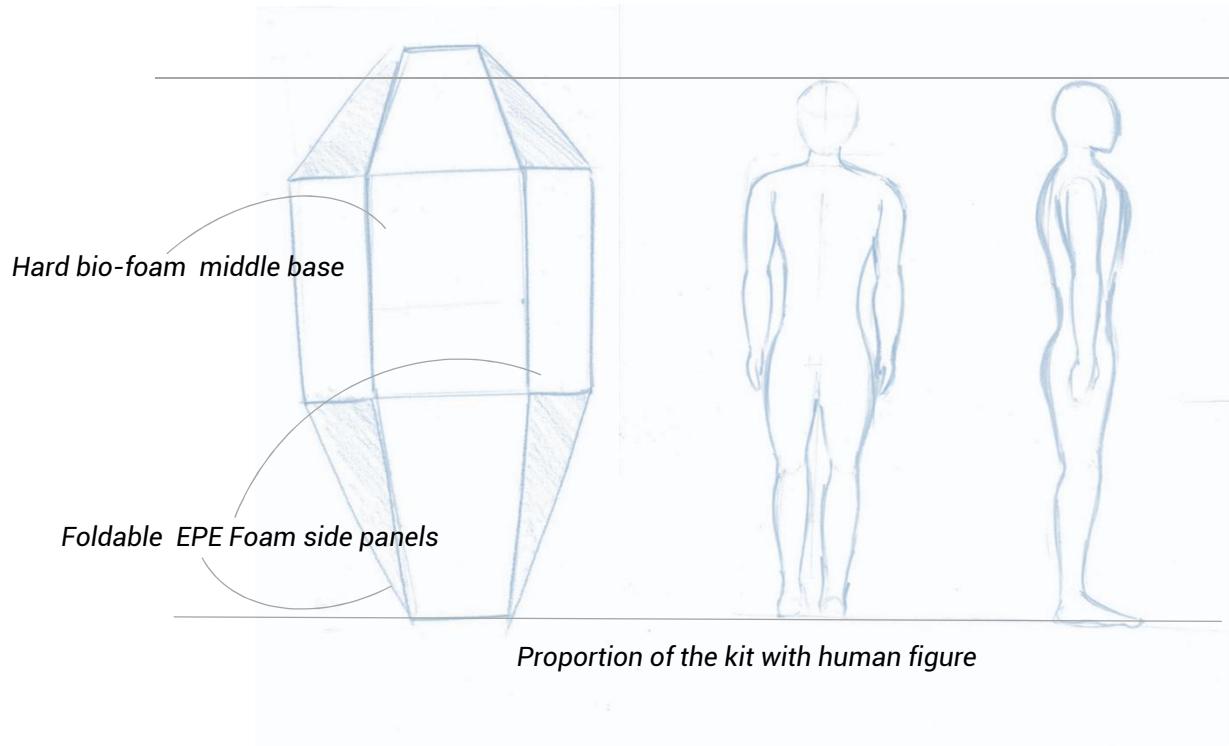
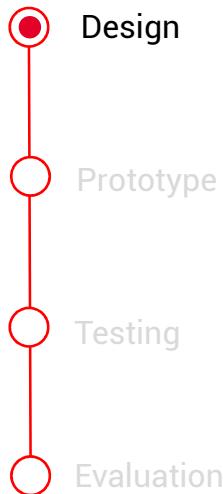
### Key points :

- Rescue a person and keep him alive
- Individual floatation device (Non motorised or propelled)
- Wearable and portable (foldable)
- Mass producible rescue kit
- Price within (approx. 1000-1200 Rs)
- Features:
  - *Rain Cover*
  - *Deployment within 30 sec*
  - *Lightweight (less than 5 kg)*
  - *Indication to the rescuers*
  - *Size – approx. length of 1 person*
  - *Prevention from drifting away – provision of rope with hook*
  - *Protection from debris*





## Iteration - 1<sup>st</sup>



Testing of -

Flotation  
Seating posture  
Toppling



## Iteration - 1<sup>st</sup>



Design



Prototype



Testing



Evaluation





## Iteration - 1<sup>st</sup>



Design



Prototype



Testing



Evaluation



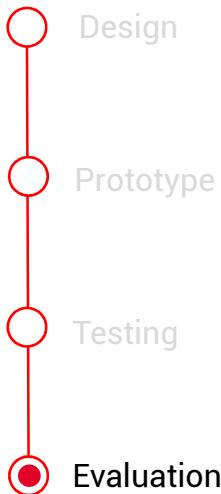


## Iteration - 1st





## Iteration - 1<sup>st</sup>



Seating Position



Leaning Backward Position

### Pros:

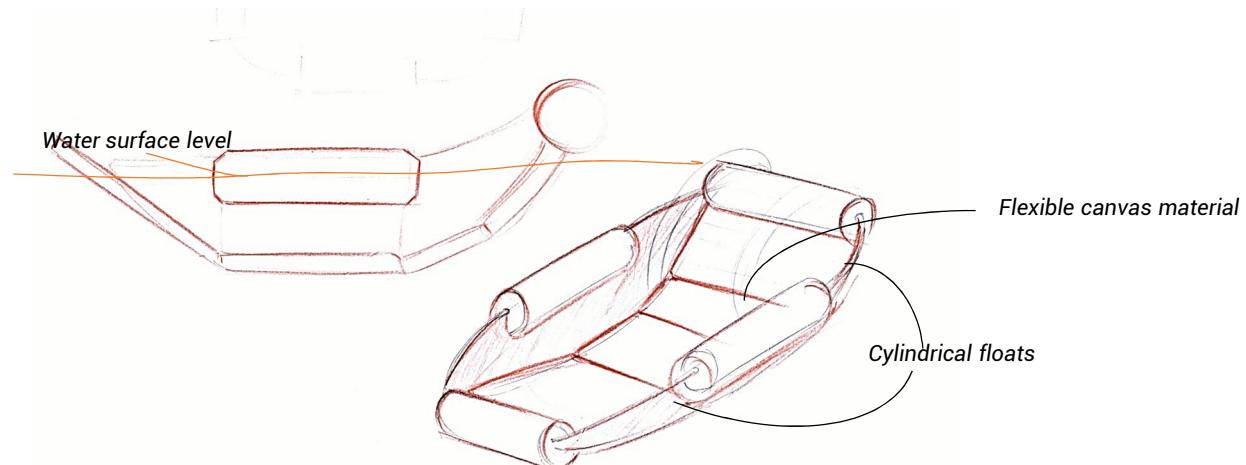
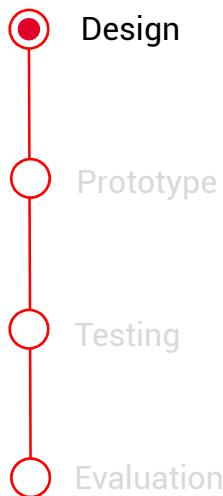
**Stable in leaning position**  
**It can take shape of body**

### Cons:

**More buoyancy required**  
**Ingress and egress is difficult**



## Iteration – 2<sup>nd</sup>





## Iteration – 2<sup>nd</sup>



Design



Prototype

Testing

Evaluation



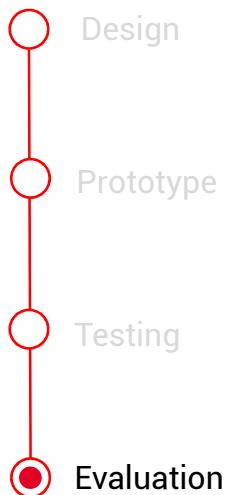


## Iteration – 2<sup>nd</sup>





## Iteration – 2<sup>nd</sup>



### Pros:

- Possibility of multiple positions**
  - Straight, recumbent
- Stable due to low C.G.**

### Cons:

- Neck support is required**
- Waterproofing**
- leg support**



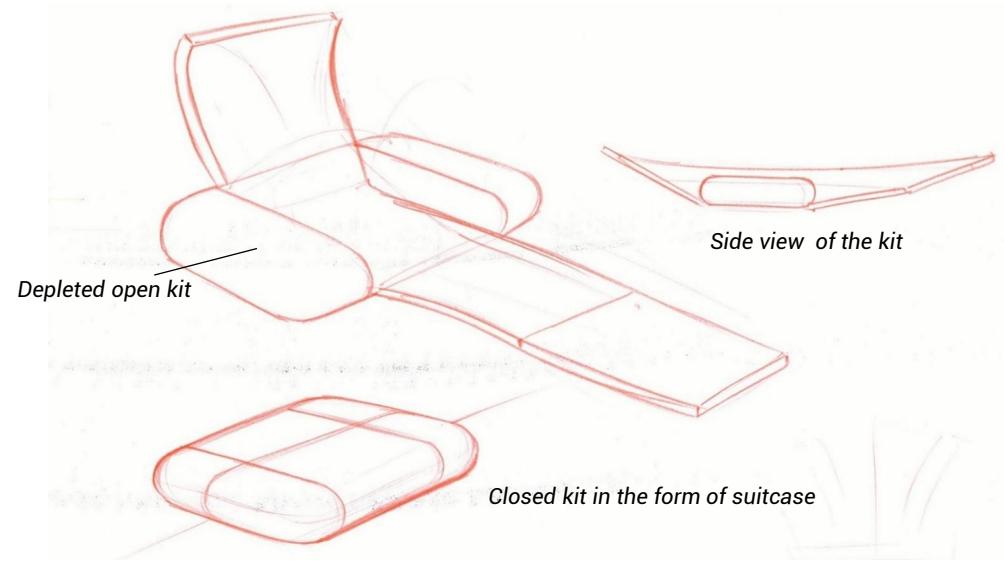
## Iteration – 3<sup>rd</sup>

Design

Prototype

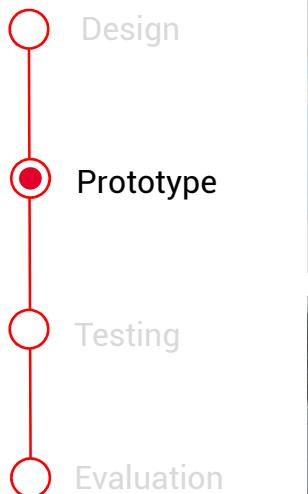
Testing

Evaluation





## Iteration - 3<sup>rd</sup>





## Iteration - 3<sup>rd</sup>





## Iteration - 3<sup>rd</sup>



Design

Prototype

Testing

Evaluation





## Iteration - 3<sup>rd</sup>



Design



Prototype



Testing



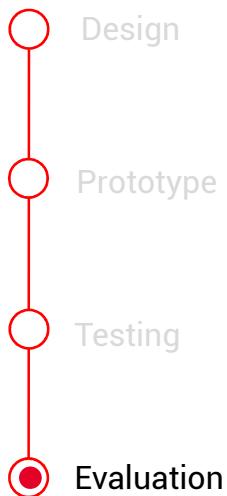
Evaluation



Testing of prototype in water



## Iteration - 3<sup>rd</sup>



Pros:  
**Possibility of multiple positions**  
- Straight, recumbent  
Balancing is good

Cons:  
**Short length of floats are less effective in toppling**  
**Waterproofing**  
**No head protection**  
**Legs are constrained**



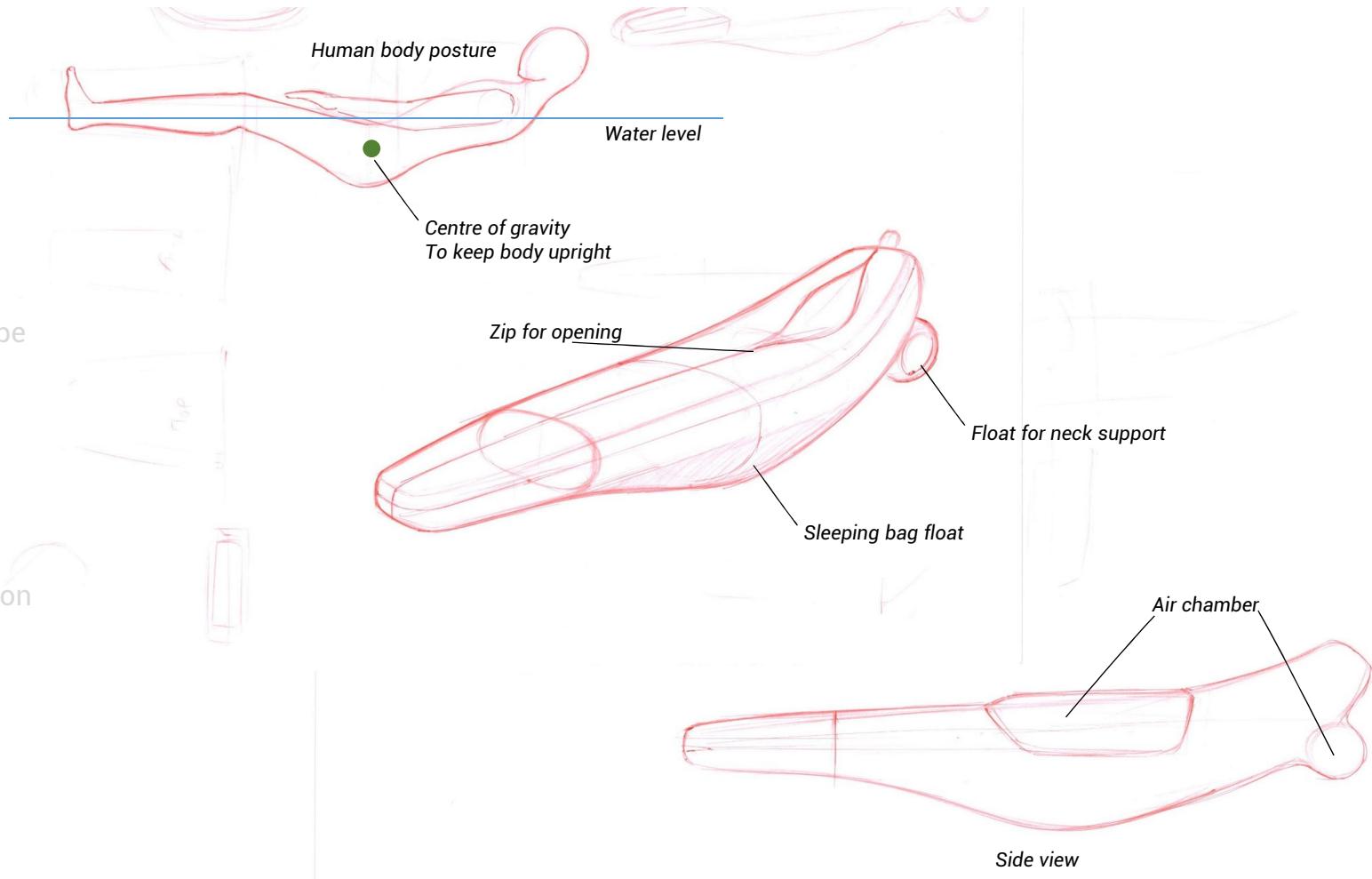
## Iteration - 4<sup>th</sup>

Design

Prototype

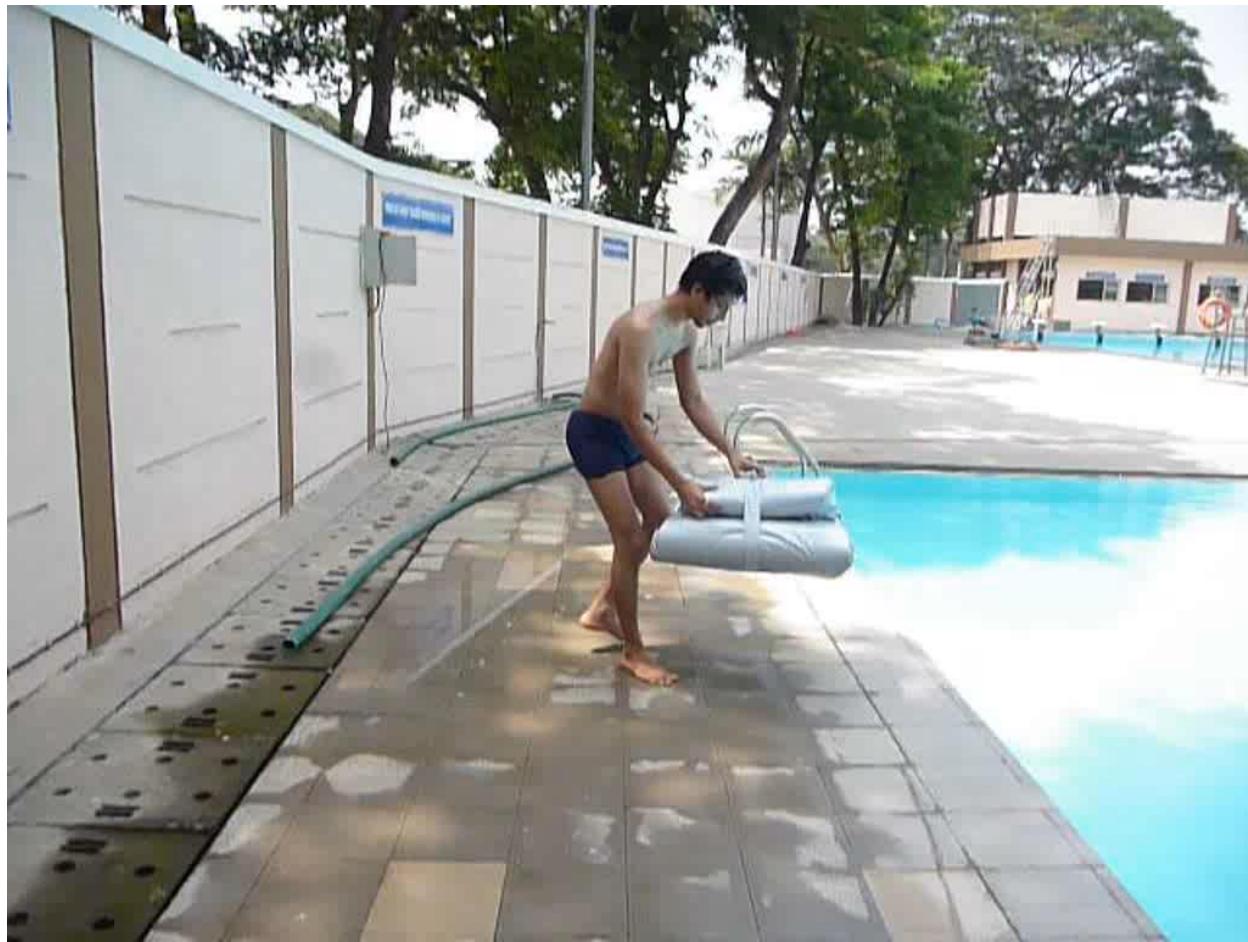
Testing

Evaluation



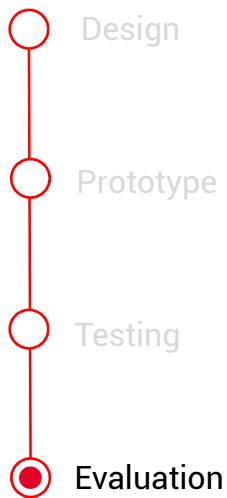


## Iteration - 4<sup>th</sup>





## Iteration - 4<sup>th</sup>



Pros:  
**Full body protection**

Cons:  
**Chest floats are inefficient for toppling**  
**Difficult to ingress and egress**  
**Legs are constrained**  
**Balancing in upright seating posture**



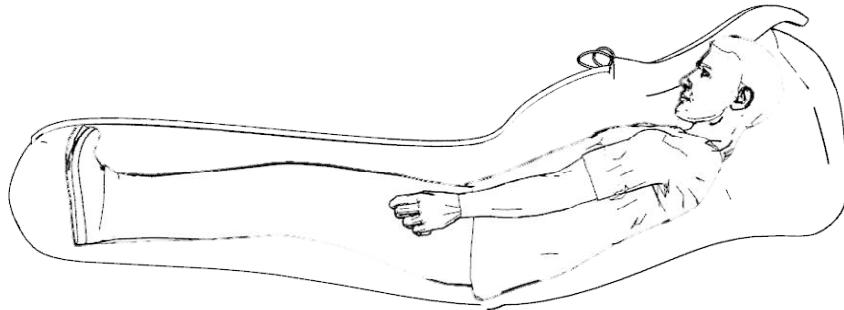
## Iteration - 5<sup>th</sup>

Design

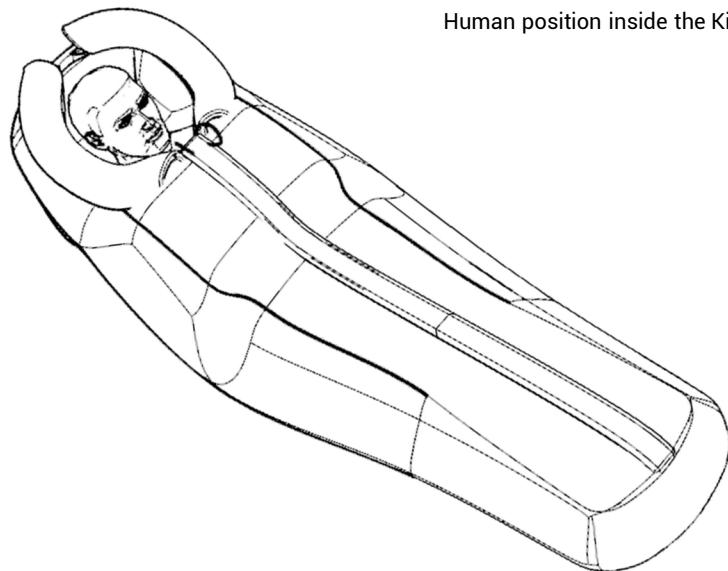
Prototype

Testing

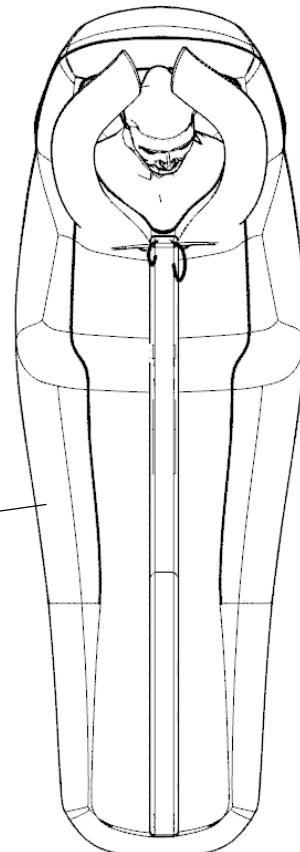
Evaluation



Human position inside the Kit



Side floats





## Iteration - 5<sup>th</sup>

- Design
- Prototype
- Testing
- Evaluation





## Iteration - 5<sup>th</sup>





## Iteration - 5<sup>th</sup>





## Iteration - 6<sup>th</sup>





## Iteration - 6<sup>th</sup>



Exploration of possibilities of floating with buoyant material



## Iteration - 6<sup>th</sup>



Exploration of possibilities of floating with buoyant material



## Iteration - 6<sup>th</sup>



Exploration of possibilities of floating with buoyant material



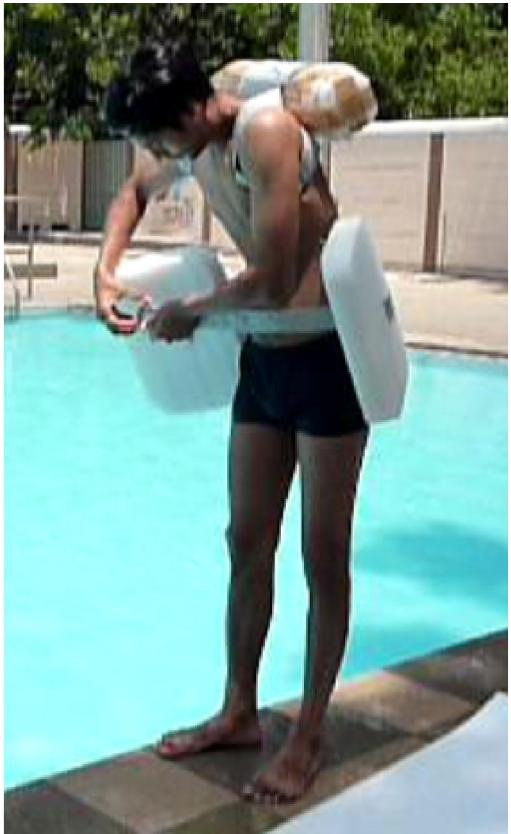
## Iteration - 6<sup>th</sup>



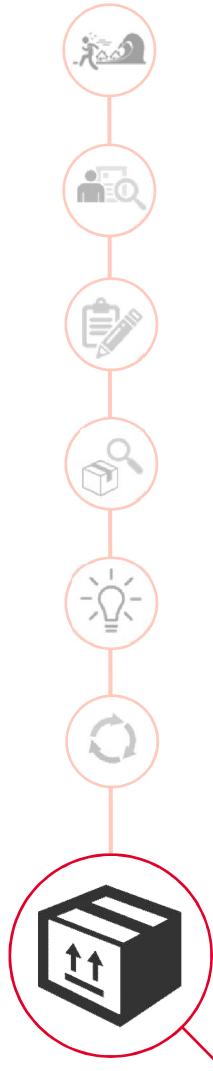
Exploration of possibilities of floating with buoyant material



## Iteration - 6<sup>th</sup>



Exploration of possibilities of floating with buoyant material

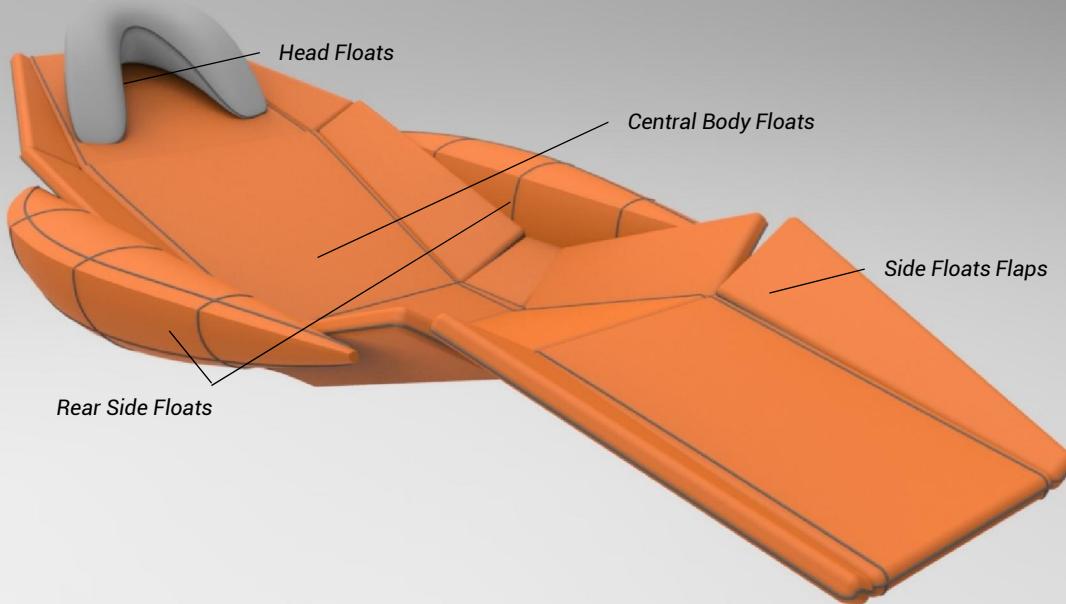


Product



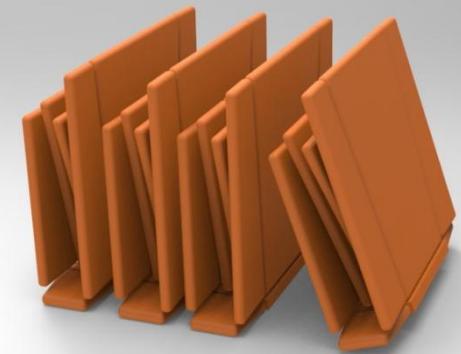


## Product CAD Model



Opened Rescue Kit

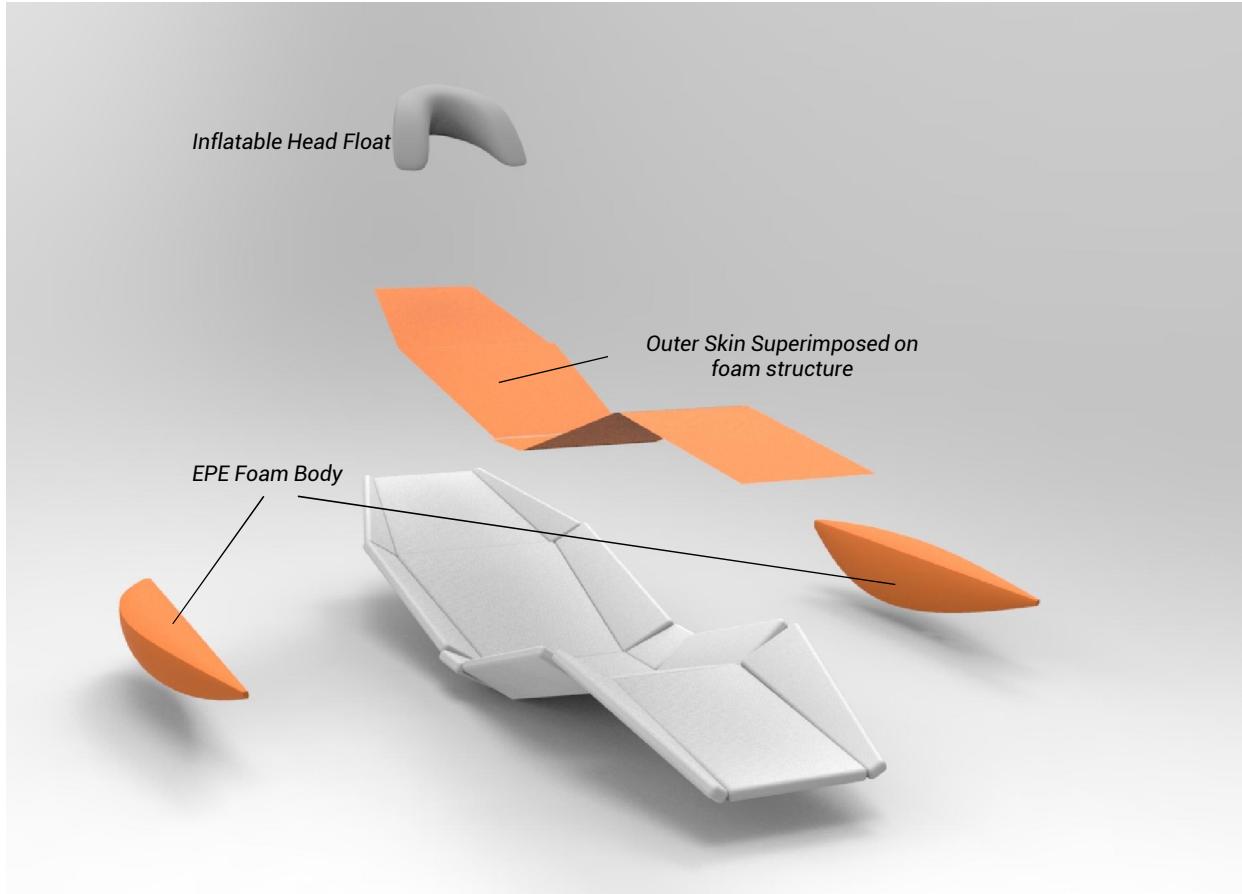
Stackability Options



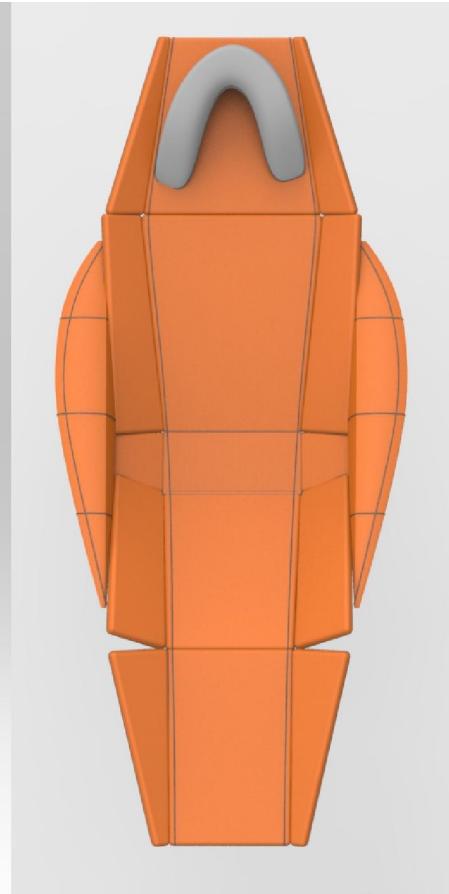
Packed Rescue Kit



## Product Exploded view



Exploded View



Float Layouts



## Product Prototype



Folded



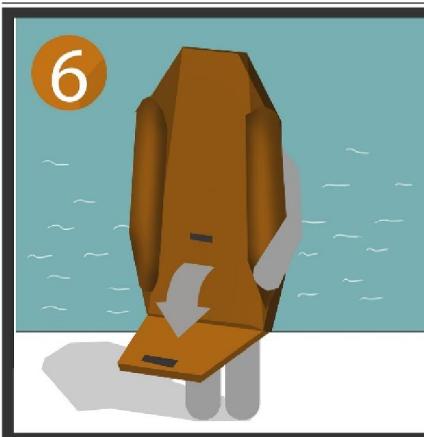
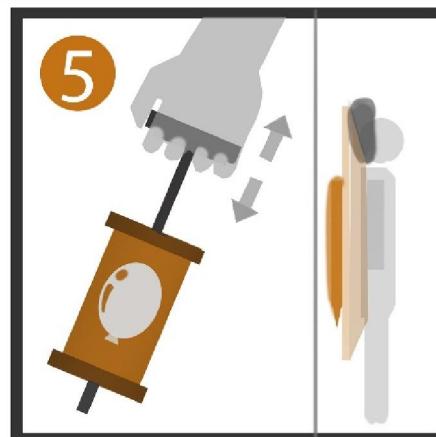
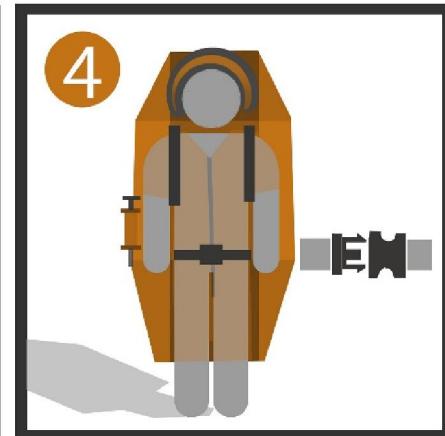
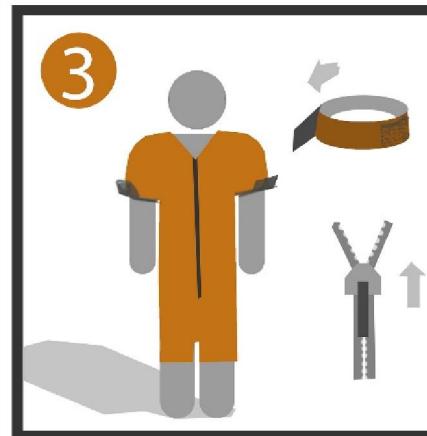
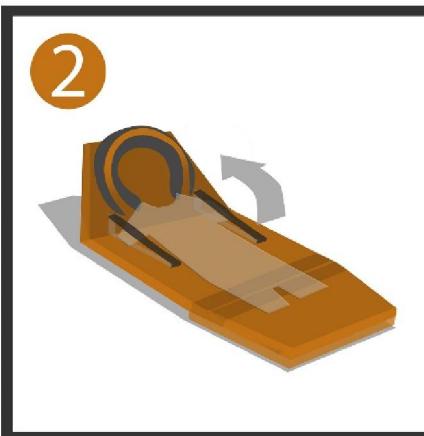
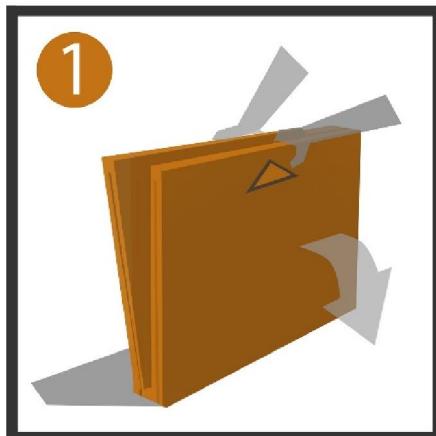
Unfolded



Usage

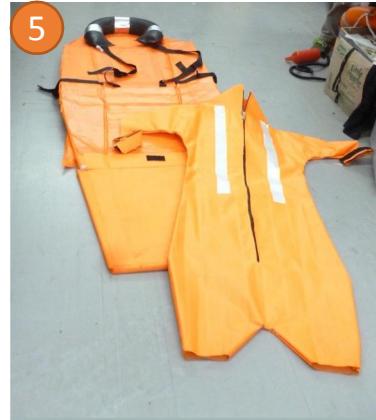


## Product Illustrations





## Product Deployment activity



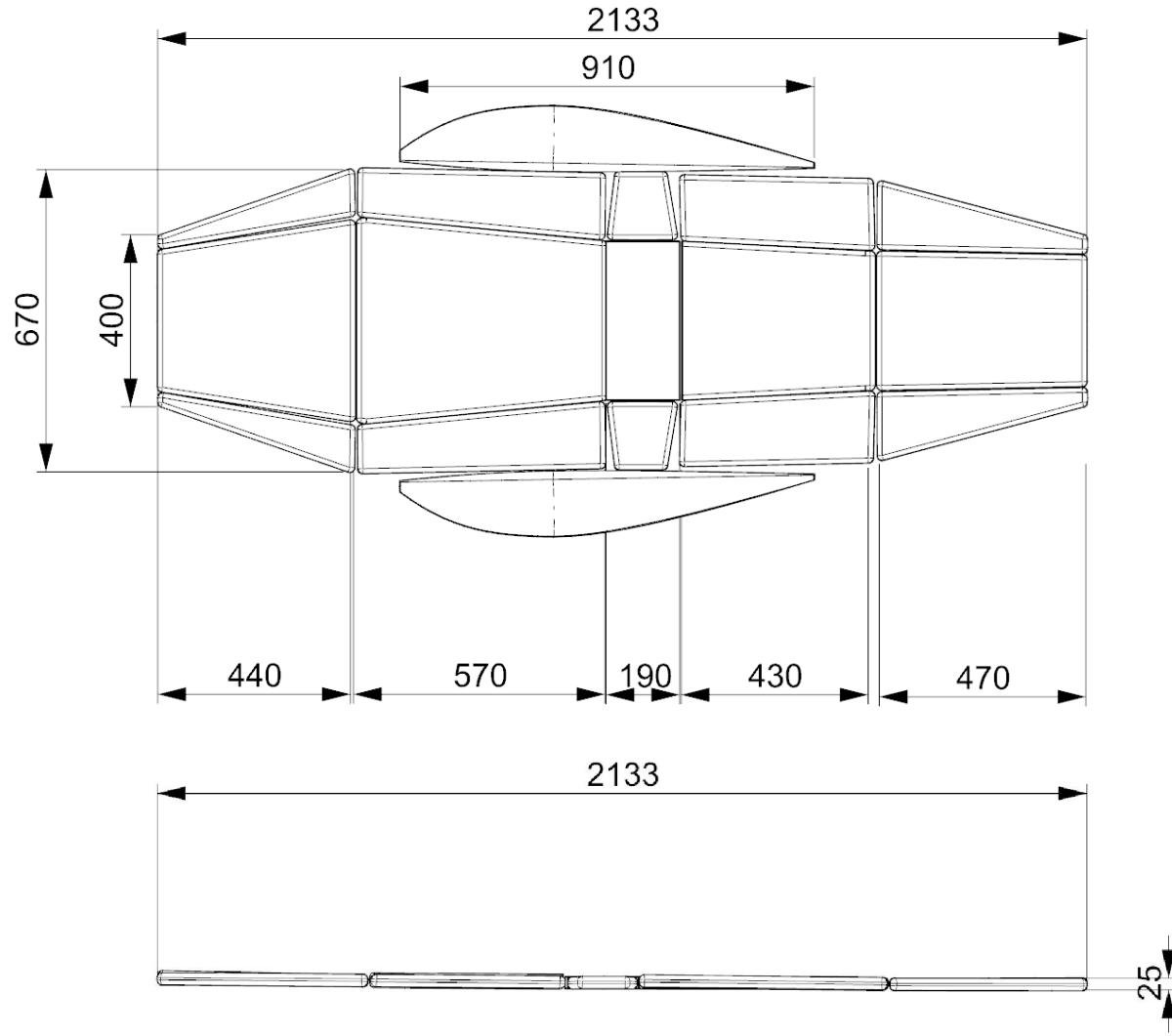


## Product Testing





## Product Blueprint





## Product scenario



Scenario – User Deployed kit and starts floating



## Product scenario



Scenario – Rescue personnel rescuing the user from the kit



**Thank you**